QNET: HVACT, DCMCT, ROTPENT, MECHKIT,
VTOL, and MYOELECTRIC

Quanser Engineering Trainer for NI-ELVIS

QNET User Manual






Table of Contents

1. Introduction

The Quanser Engineering Trainers for NI ELVIS (QNET) modules are listed and briefly described in Table 1, below, and pictured in figures 1, 2, 3, 4, 5, and 6. These devices work with both the NI ELVIS I and the NI ELVIS II. Section 2 demonstrates how to setup a QNET with an NI ELVIS. The hardware of each QNET system is described in sections 3, 4, 5, 6, and 7. Some helpful LabVIEW hints when using the QNET VIs are given in Section 9 along with a troubleshooting guide in Section 10.

QNET	*Name*	*Full Name*	*Plant Description*
QNET-012	HVACT	Heating-Ventilation Trainer	Process Control.
QNET-010	DCMCT	DC Motor Control Trainer	Motion Control.
QNET-011	ROTPENT	Rotary Inverted Pendulum Trainer	Task-Based Control.
QNET-015	MECHKIT Trainer	Mechatronic Sensors Trainer	Mechatronics.
QNET-014	VTOL Trainer	Vertical Take-Off and Landing Trainer	Aerospace.
QNET-016	MYOELECTRIC Trainer	Myoelectric Trainer	Biomedical

Table 1: Summary of Quanser Engineering Trainers for NI ELVIS (QNET) devices.

Figure 1: QNET-HVACT

Figure 2: QNET-DCMCT

Figure 3: QNET-ROTPENT

Figure 4: QNET-MECHKIT Trainer

Figure 5: QNET-VTOL Trainer

Figure 6: QNET-MYOELECTRIC Trainer

2. Setting up a QNET

As illustrated in Figure 7, the QNET boards can easily be connected to an NI ELVIS system.

Figure 7: Setting up QNETs.

Go through the instructions in Section 2.1 to to setup a QNET with an NI ELVIS II or Section 2.2 if using the traditional NI ELVIS (i.e. NI ELVIS I).

2.1. QNET and NI ELVIS II Setup Procedure

The procedure to install a Quanser Engineering Trainer (QNET) module on the NI ELVIS II is explained in this section. The installed system using the QNET DC Motor module is pictured in Figure 8.

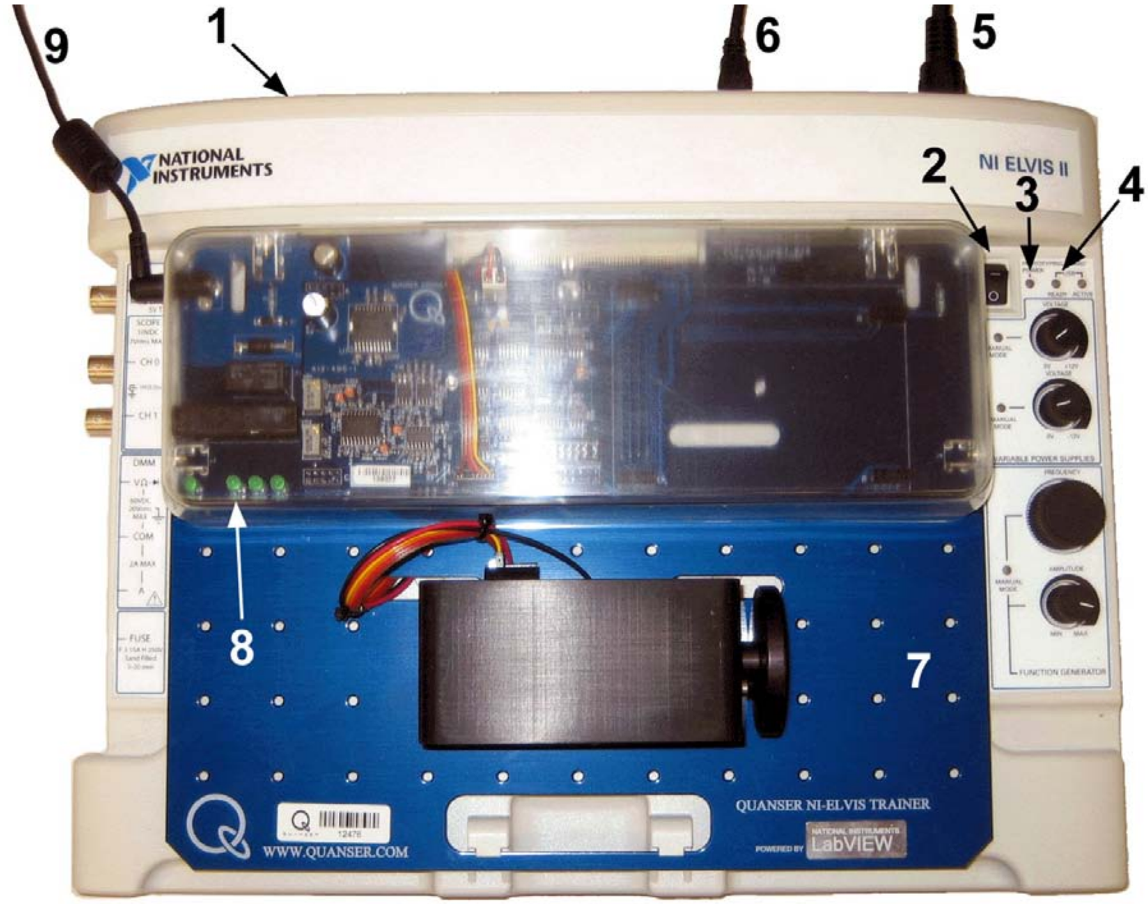

Figure 8: Components on ELVIS II and QNET.

Some of the components used in the installation procedure are located and marked by an ID number in Figure 8 and described in the Table 2, below.

ID #	Description	ID #	Description
1	NI ELVIS II	6	USB Connection between PC and ELVIS II
2	Prototyping Board Power Switch	7	QNET DC Motor Control Trainer
3	Power LED	8	QNET Power LEDs
4	Ready LED	9	QNET Power Cable for QNET
5	Power Cable for ELVIS II		

Table 2: ELVIS II and QNET components.

Follow these instructions to setup a QNET board on an ELVIS II:

1. **Do NOT make the following connections while power is supplied to the hardware!**
2. Place the small opening on the front of the QNET board over the mounting bracket on the NI

ELVIS II.

3. Slide the PCI connector of the QNET module end into the female connector on the NI ELVIS II. Make sure it is connected properly.
4. Connect the ELVIS II power cable.
5. Connect the ELVIS II USB cable to the PC.
6. Connect the supplied QNET transformer to the QNET power jack on the QNET module.
   Note: Not required for the QNET mechatronic sensors trainer.
7. Power the NI ELVIS II by turning ON the *System Switch* on the rear panel.
8. Turn ON the *Prototyping Board Power* switch, ID #2 shown in Figure 8.
9. **Turn OFF the *Prototyping Board* switch if**

   (1) On the QNET-DCMCT, QNET-ROTPENT, or QNET-VTOL Trainer the DC motor begins to turn, or
   (2) On the QNET-HVACT the halogen light turns on brightly.

   Take extra care when powering the QNET module to avoid causing any damage!
10. The *Power* and *Ready* LEDs of the NI ELVIS II unit should be lit as shown in Figure 9, below.

Figure 9: Ready and Power LEDs on NI ELVIS II.

11. As pictured in Figure 10, verify that the **+15V**,**-15V**, **+5V**, and **+B** LEDs on the QNET module are lit. They indicate that the board has been properly connected to the ELVIS unit.
    Note: For the QNET-MECHKIT, ensure the +15V,-15V, and +5V LEDs are lit (it does not require QNET power supply).

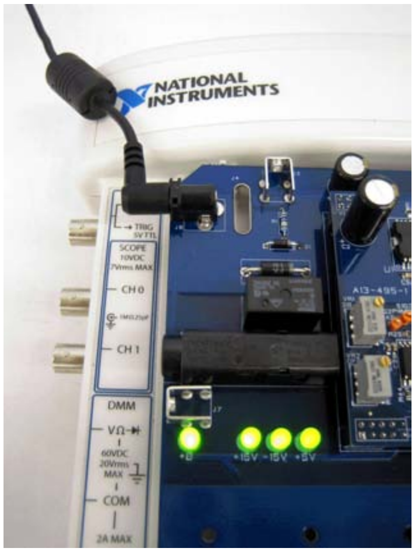

Figure 10: QNET LEDs should all be on.

2.2. QNET and ELVIS I Setup Procedure

The procedure to setup a QNET on the NI ELVIS I is explained in this section. The installed system using the QNET DC Motor module is pictured in Figure 11.

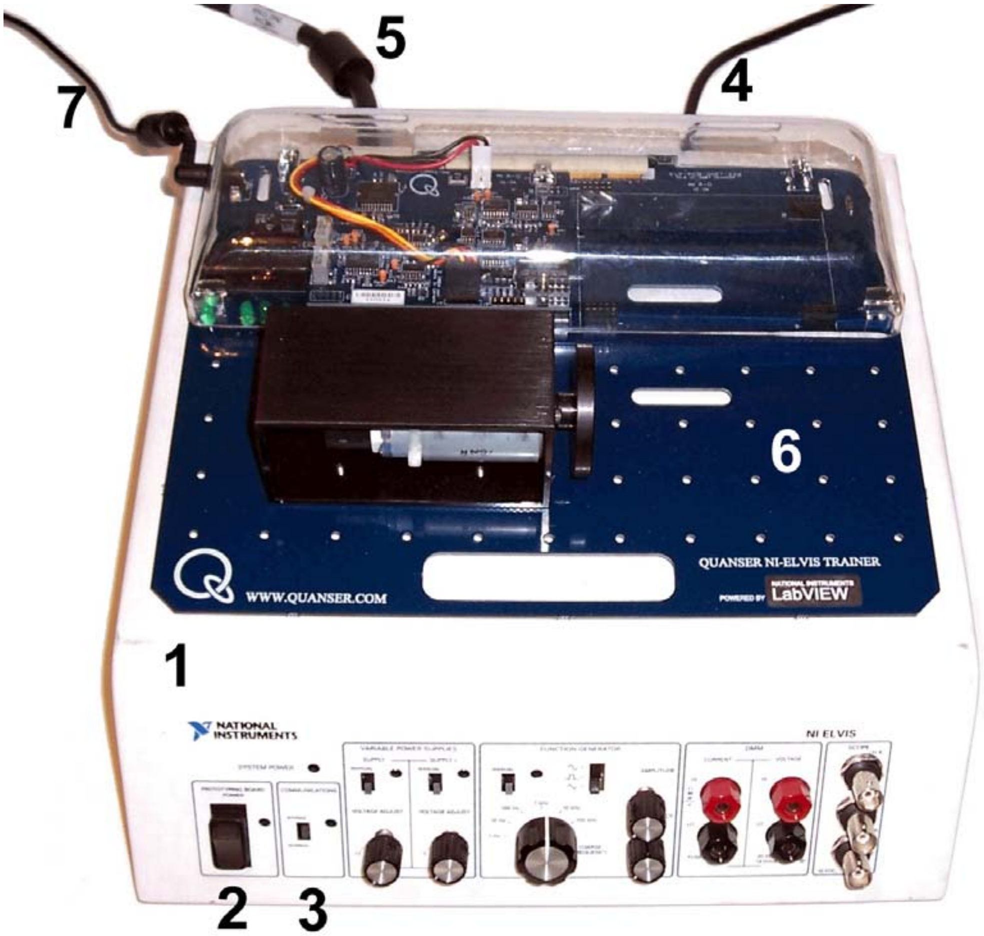

Figure 11: NI ELVIS and QNET-DCMCT setup for use with LabVIEW.

Some of the components used in the installation procedure are located and marked by an ID number in Figure 11 and described in the Table 3, below.

ID #	Description	ID #	Description
1	NI ELVIS Benchtop Workstation (Traditional NI ELVIS or NI ELVIS I)	5	68-Pin E-Series or M-Series DACB Cable
2	Prototyping Board Power Switch	6	QNET DC Motor Control Trainer
3	Communications Switch	7	QNET Power Cable
4	Power Cable of NI ELVIS I		

Table 3: ELVIS I and QNET components.

Follow these instructions to setup a QNET board on an ELVIS I:

1. **Do NOT make the following connections while power is supplied to the hardware!**
2. Place the small opening on the front of the QNET board over the mounting bracket on the NI

ELVIS (note that some ELVIS workstations may not have mounting brackets).

3. Slide the PCI connector of the QNET module end into the female connector on the NI ELVIS II. Make sure it is connected properly.
4. Connect the NI ELVIS power cable shown as ID #4 in Figure 11.
5. Connect the QNET power cable labeled ID #7 in Figure 11.
   Note: Not required for the QNET mechatronic sensors trainer.
6. Ensure the *Prototyping Board Power* switch, ID #2, is set to the OFF position and the *Communications* switch, ID #3, is set to the BYPASS mode.
7. Power the *NI ELVIS Benchtop Workstation* by turning the *Standby Switch* on the rear panel of the system to ON.
8. Turn ON the *Prototyping Board Power* switch.
9. **Turn OFF the *Prototyping Board* switch if**

   (1) On the QNET-DCMCT, QNET-ROTPENT, or QNET-VTOL Trainer the DC motor begins to turn, or
   (2) On the QNET-HVACT the halogen light turns on brightly.

   Take extra care when powering the QNET module to avoid causing any damage!
10. The *System Power*, *Prototyping Board,* and *Communications* LEDs situated on the front panel of the NI ELVIS unit should all be lit.
11. Verify that the **+15V**, **-15V**, **+5V,** and **+B** LEDs on the QNET module are lit. They indicate that the board has been properly connected to the ELVIS unit.
    Note: For the QNET-MECHKIT, ensure the +15V,-15V, and +5V LEDs are lit (it does not require QNET power supply).

3. QNET-HVACT

3.1. General Overview

The photograph in Figure 12 shows an overview and the general layout of the QNET heating and ventilation trainer (HVAC trainer) system.

CAUTION: Ensure the HVAC trainer is setup as dictated in Section 2 and used as described in the Reference [1]. The HVAC trainer is susceptible to protection impairment if not used as specified.

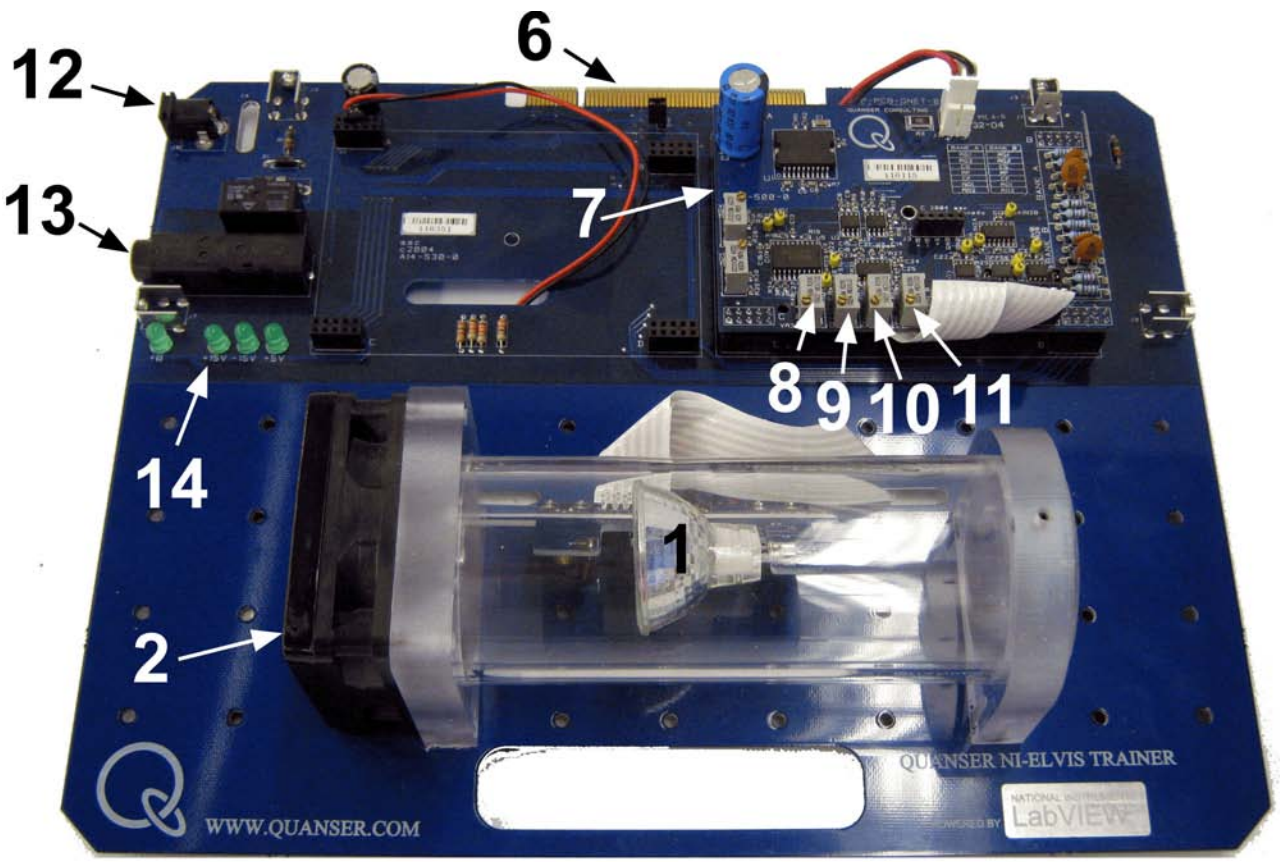

Figure 12: General layout of QNET-HVACT.

The HVACT components in Figure 12 and Figure 13 are located and identified by a unique ID in Table Table 4.

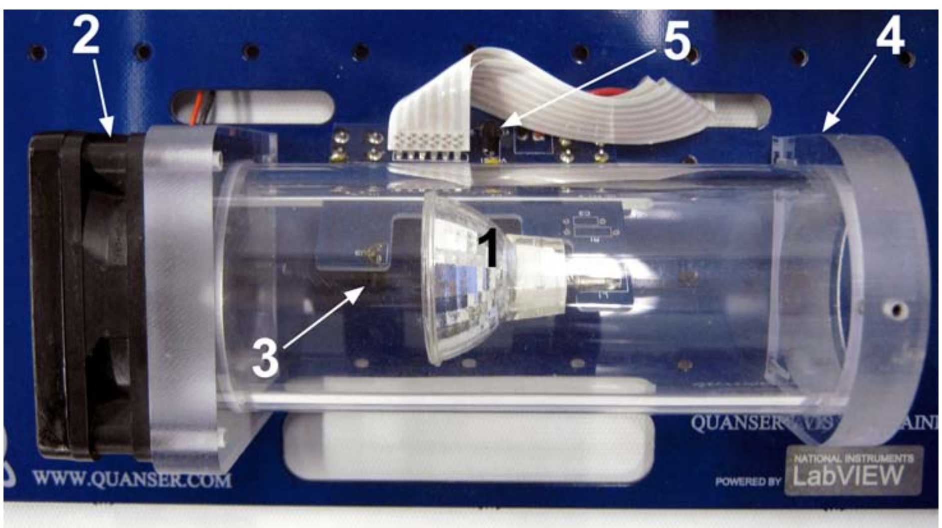

Figure 13: Components of QNET-HVACT heating chamber.

ID #	Description	ID #	Description
1	Halogen light bulb (i.e. heater)	8	Chamber thermistor gain
2	Fan (i.e. cooling)	9	Chamber thermistor offset
3	Thermistor chamber temperature sensor	10	Ambient thermistor offset
4	Chamber	11	Ambient thermistor gain
5	Thermistor ambient temperature sensor	12	24V QNET power jack
6	PCI connector to NI ELVIS: for interfacing QNET module with DAC.	13	Fuse
7	QNET PWM/Encoder board	14	+B, +15V, -15V, +5V LEDs

Table 4: HVACT Component Nomenclature

3.2. System Schematic

A schematic of the HVACT system interfaced with a DAQ device is provided in Figure 14.

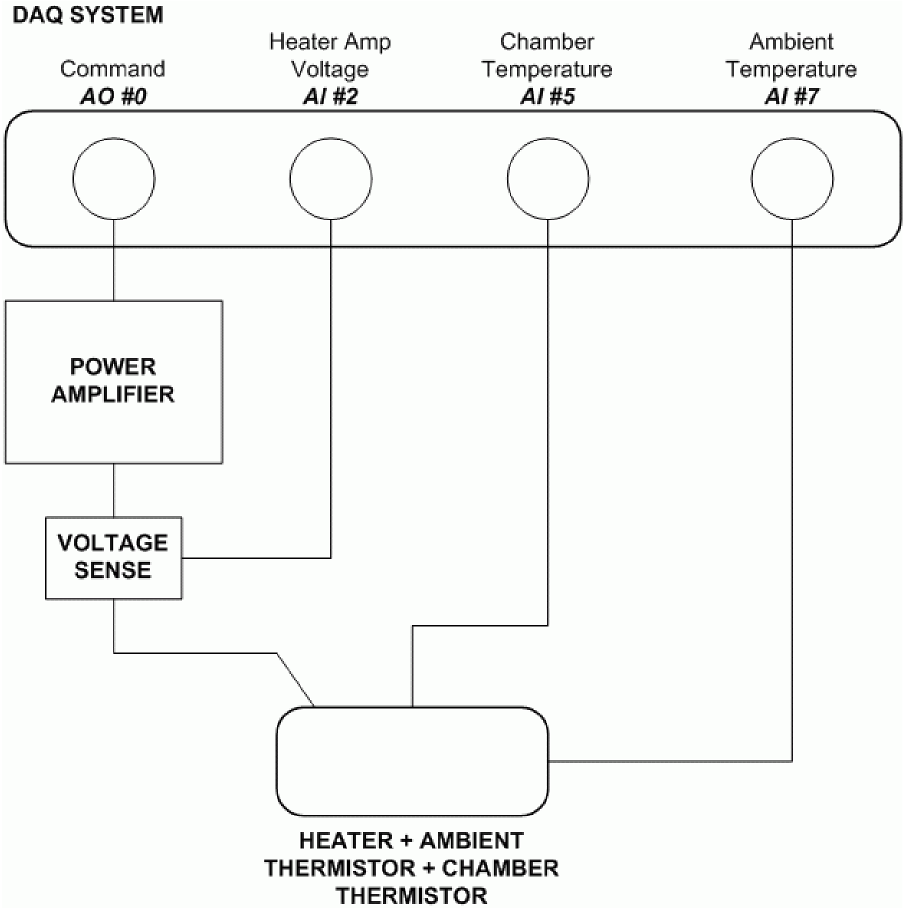

Figure 14: Schematic of QNET-HVACT system.

3.3. Component Description

This Section provides a description of the individual elements comprising the full HVACT system.

3.3.1. Halogen Light

The halogen light is rated at 12-Volts.

3.3.2. Fan

The blower is a 24-Volt variable-speed fan. There is a constant voltage of 16-Volts applied to the fan.

3.3.3. Chamber

The chamber, or duct, is constructed from Plexiglas.

3.3.4. Pulse-Width Modulated Power Amplifier

A PWM power amplifier is used to drive the halogen bulb to heat the chamber. The input to the

amplifier is the output of the Digital-to-Analog converter (i.e. D/A) of channel #0 on the DAQ. The maximum output voltage of the amplifier is 24 V. Its maximum peak current is 5 A and the maximum continuous current is 4 A. The amplifier gain is 2.3 V/V.

3.3.5. Analog Current Measurement: Current Sense Resistor

A series load resistor of 0.1 Ohms is connected to the output of the PWM amplifier. The signal is amplified internally to result in a sensitivity of 1.0 V/A. The obtained current measurement signal is available at the Analog-to-Digital (i.e. A/D) of channel #0. Such a current measurement can be used to monitor the current in the heater.

3.3.6. Analog Voltage Measurement: Voltage Sense

The analog signal proportional to the voltage output of the PWM amplifier is available at the Analog-to-Digital (i.e. A/D) channel #2 of the DACB. The voltage sensor sensitivity is 3.33 V/V. Such a voltage measurement can be used to monitor the voltage applied to the heater.

3.3.7. Analog Temperature Measurement: Thermistor Sensor

An analog voltage signal proportional to the temperature is available at the Analog-to-Digital (i.e. A/D) Input channels #5 and #7 of the DAQ. The AI #5 channel gives the chamber temperature signal and the AI #7 channel reads the ambient temperature signal. The sensitivity of the thermistor sensor is 20.0 ^{o}C/V.

3.3.8. Fuse

The QNET power amplifier has a 250 V, 3 A fuse.

3.3.9. QNET Power Supply

The HVACT has a 24-Volt DC power jack to power the on-board PWM amplifier. It is called the QNET power supply. The +B LED on the QNET board turns bright green when the amplifier is powered.

CAUTION: Please make sure you use the correct type of wall transformer or you will damage the system. It should supply 24 VDC and be rated at 3.0 A.

3.4. Specifications

The specifications of the HVACT system model parameters are given in Table 5.

Symbol	***Description***	***Value***	***Unit***
	Halogen Light:		
Kv	Heater ramp gain.	0.01	°C/(V.s)
	Pulse-Width Modulated Amplifier:		
Vmax	PWM amplifier maximum output voltage	24	V
	PWM amplifier maximum output current	5	A
	PWM amplifier gain	2.3	V/V

Table 5: HVACT model parameter and PWM power amplifier specifications.

The specifications on the HVACT system sensors are given in Table 6.

Description	***Value***	***Unit***
Current Sense:		
Current calibration	1	A/V
Current sense resistor	0.1	ohms
Voltage Sense:		
Voltage calibration.	3.33	V/V
Thermistor:		
Thermistor calibration at QNET A/D input	20	°C/V

Table 6: HVACT sensor parameter specifications.

3.5. Environmental

The HVACT environmental operating conditions are given in Table 7.

Description	***Value***	***Unit***
Operating temperature	15 to 35	°C
Humidity	20 to 90	%

Table 7: QNET HVACT environmental operating conditions.

CAUTION: Ensure the unit is operated under the temperature and humidity conditions given in Table 7. Otherwise, there may be some issues with the motion control experiment results.

3.6. Calibration

Follow this procedure to calibrate the thermistor sensors that measure the chamber and ambient temperature on the QNET-HVACT module:

1. Power the NI ELVIS and the QNET as described in Section 2.
2. Open and run the LabVIEW virtual instrument QNET_HVACT_On_Off_Control as described in the Reference [1].
3. **Let the fan cool down the chamber for at least 2 minutes and make sure the heater if OFF!** In the *Digital Scopes* section of the VI, make sure the *Chamber Temp* and the *Ambient Temp* are reading values suitable for the control laboratory. See the Troubleshooting Section on Page 53 for more information.
4. If the sensors definitely need to be re-calibrated, remove the plastic cover on the QNET-HVACT module by loosening its four screws.
5. The thermistor offset can be changed on the QNET PWM/Encoder board. The offset of the chamber thermistor and ambient thermistor sensors are ID #9 and ID #10 in Figure 12. Take a screwdriver with a small head and vary the knob corresponding to the sensor that needs to be calibrated. The offset is decreased by turning the knob clockwise.
6. While the knob is turned, examine the change in temperature in the *Digital Scopes* section of the VI. Adjust it until the chamber and/or ambient temperature read acceptable values.
7. **Do not change the sensor gain adjustments, ID #8 and ID #11 in Figure 12.** They are both turned counter-clockwise to get the maximum gain before the shipment.

4. QNET-DCMCT

4.1. General Overview

The photograph in Figure 15 shows an overview and the general layout of the QNET DC Motor Control Trainer (DCMCT) system.

CAUTION: Ensure the DCMCT is setup as dictated in Section 2 and used as described in the Reference [1]. The DCMCT is susceptible to protection impairment if not used as specified.

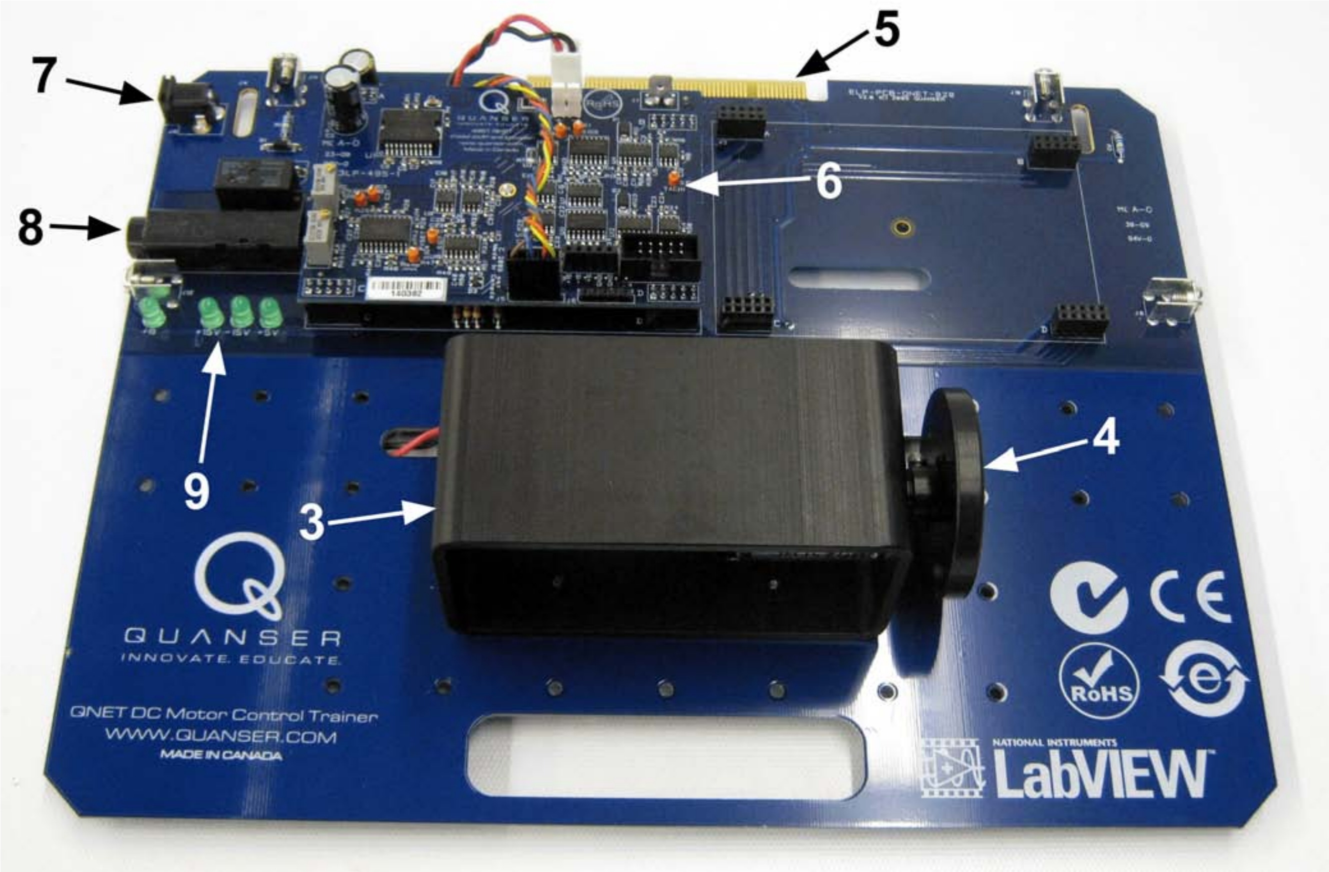

Figure 15: General layout of QNET DCMCT.

The DCMCT components in Figure 15and Figure 16 are located and identified by a unique ID in Table 8.

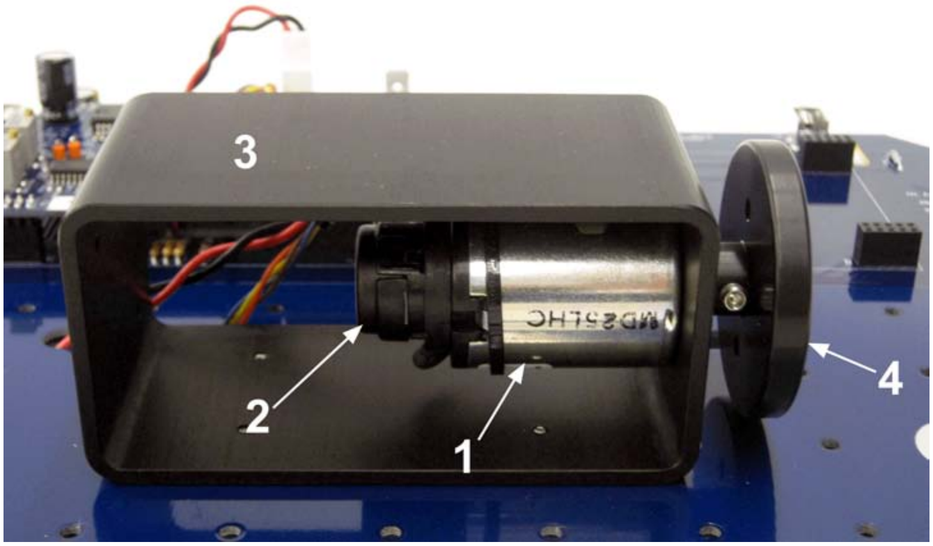

Figure 16: QNET DC motor components.

ID #	Description	ID #	Description
1	DC motor	6	QNET PWM/Encoder board
2	High-resolution encoder	7	24V QNET power jack
3	Motor metal chamber	8	Fuse
4	Inertial load	9	+B, +15V, -15V, +5V LEDs
5	PCI connector to NI ELVIS: for interfacing QNET module with DAC		

Table 8: DCMCT component nomenclature.

4.2. System Schematic

A schematic of the DCMCT system interfaced with a DAQ device is provided in Figure 17.

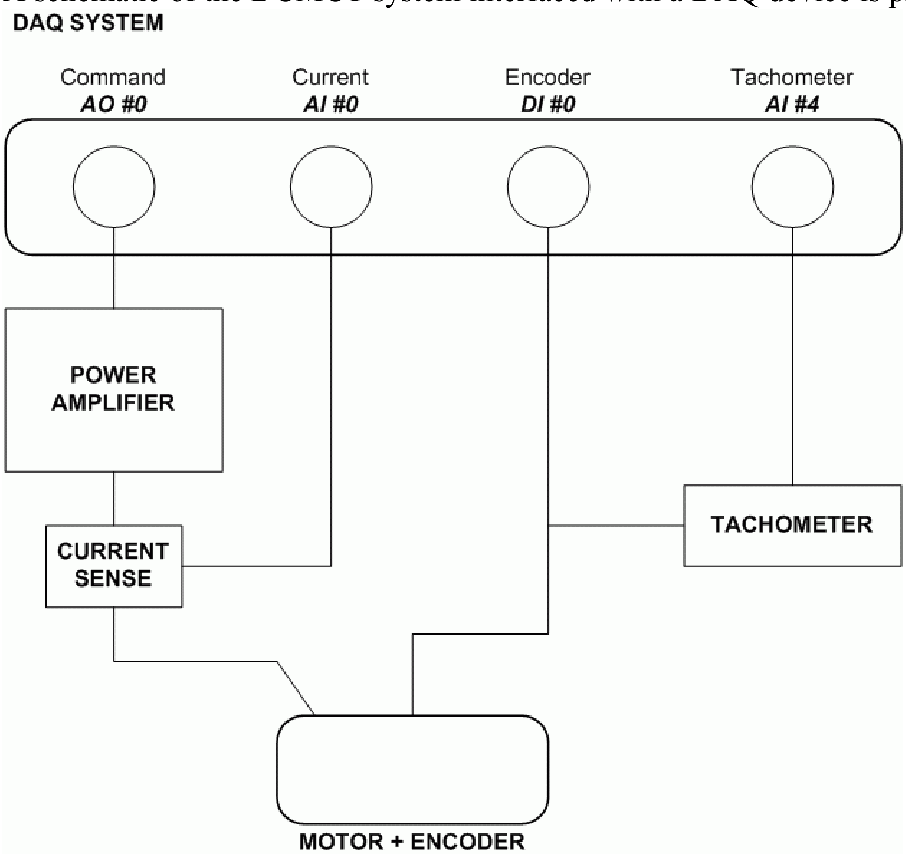

Figure 17: Schematic of QNET-DCMCT system.

4.3. Component Description

This section provides a description of the individual elements comprising the full DCMCT system.

4.3.1. DC Motor

The 12-Volt DC motor has 5 commutator segments, 64 windings per pole, and has a flux ring. The Coulomb friction of the motor corresponds to a voltage between 0.5 and 1.5 V.

4.3.2. Pulse-Width Modulated Power Amplifier

A PWM power amplifier is used to drive the motor. The input to the amplifier is the output of the Digital-to-Analog converter (i.e. D/A) of channel #0 on the DAQ. The maximum output voltage of the amplifier is 24 V. Its maximum peak current is 5 A and the maximum continuous current is 4 A. The amplifier gain is 2.3 V/V.

4.3.3. Analog Current Measurement: Current Sense Resistor

A series load resistor of 0.1 Ohms is connected to the output of the PWM amplifier. The signal is amplified internally to result in a sensitivity of 1.0 V/A. The obtained current measurement signal is available at the Analog-to-Digital (i.e. A/D) of channel #0. Such a current measurement can be used to monitor the current running in the motor.

4.3.4. Digital Position Measurement: Optical Encoder

Digital position measurement is obtained by using a high-resolution quadrature optical encoder. This optical encoder is directly mounted to the rear of the motor. The encoder count measurement is available at Digital Input (i.e. DI) channel #0 of the DAQ.

4.3.5. Analog Speed Measurement: Tachometer

An analog signal proportional to motor speed is available at the Analog-to-Digital (i.e. A/D) Input channel #4 on the DAQ. It is digitally derived from the encoder signal on the QNET DCMCT board.

4.3.6. Fuse

The QNET power amplifier has a 250 V, 3 A fuse.

4.3.7. QNET Power Supply

The DCMCT module has a 24-Volt DC power jack to power the on-board PWM amplifier. It is called the QNET power supply. The +B LED on the QNET board turns bright green when the amplifier is powered.

CAUTION: Please make sure you use the correct type of wall transformer or you will damage the system. It should supply 24 VDC and be rated at 3.0 A.

4.4. Specifications

The specifications of the DCMCT system model parameters are given in Table 9.

Symbol	***Description*** ***Motor:***	***Value***	***Unit***
R_m	Motor armature resistance.	8.7	Ohm
K_t	Motor torque constant.	0.03334	N.m
K_m	Motor back-emf constant (same as K_t in SI units).	0.03334	V/(rad/s)
J_m	Moment of inertia of motor rotor	1.80E-006	kg.m^2
	Maximum continuous torque	0.10	N.m
	Maximum power rating	20.0	W
	Maximum continuous current	1.0	A
M_l	Inertial load disc mass	0.033	kg
r_l	Inertial load disc radius	0.0242	m
	Pulse-Width Modulated Amplifier:		
V_{max}	PWM amplifier maximum output voltage	24	V
	PWM amplifier maximum output current	5	A
	PWM amplifier gain	2.3	V/V

Table 9: DCMCT model parameter and PWM power amplifier specifications.

The specifications on the DCMCT system sensors are given in Table 10.

Description ***Current Sense:***	***Value***	***Unit***
Current calibration	1.0	A/V
Current sense resistor	0.1	ohms
Encoder:		
Encoder line count	360	lines/rev
Encoder resolution (in quadrature mode)	0.25	deg/count
Encoder type	TTL	
Encoder signals	A,B	
Tachometer:		
Tachometer calibration at QNET A/D input	2987	RPM/V

Table 10: DCMCT sensor parameter specifications.

4.5. Environmental

The DC motor control trainer environmental operating conditions are given in Table 11.

Description	*Value*	*Unit*
Operating temperature	15 to 35	°C
Humidity	20 to 90	%

Table 11: QNET DC motor control trainer environmental operating conditions.

CAUTION: Ensure the unit is operated under the temperature and humidity conditions given in Table 11. Otherwise, there may be some issues with the heating and cooling results.

5. QNET-ROTPENT

5.1. General Overview

The photograph in Figure 18 shows an overview and the general layout of the QNET Rotary Pendulum Control Trainer (ROTPENT) device.

CAUTION: Ensure the ROTPENT is setup as dictated in Section 2 and used as described in the Reference [1]. The ROTPENT is susceptible to protection impairment if not used as specified.

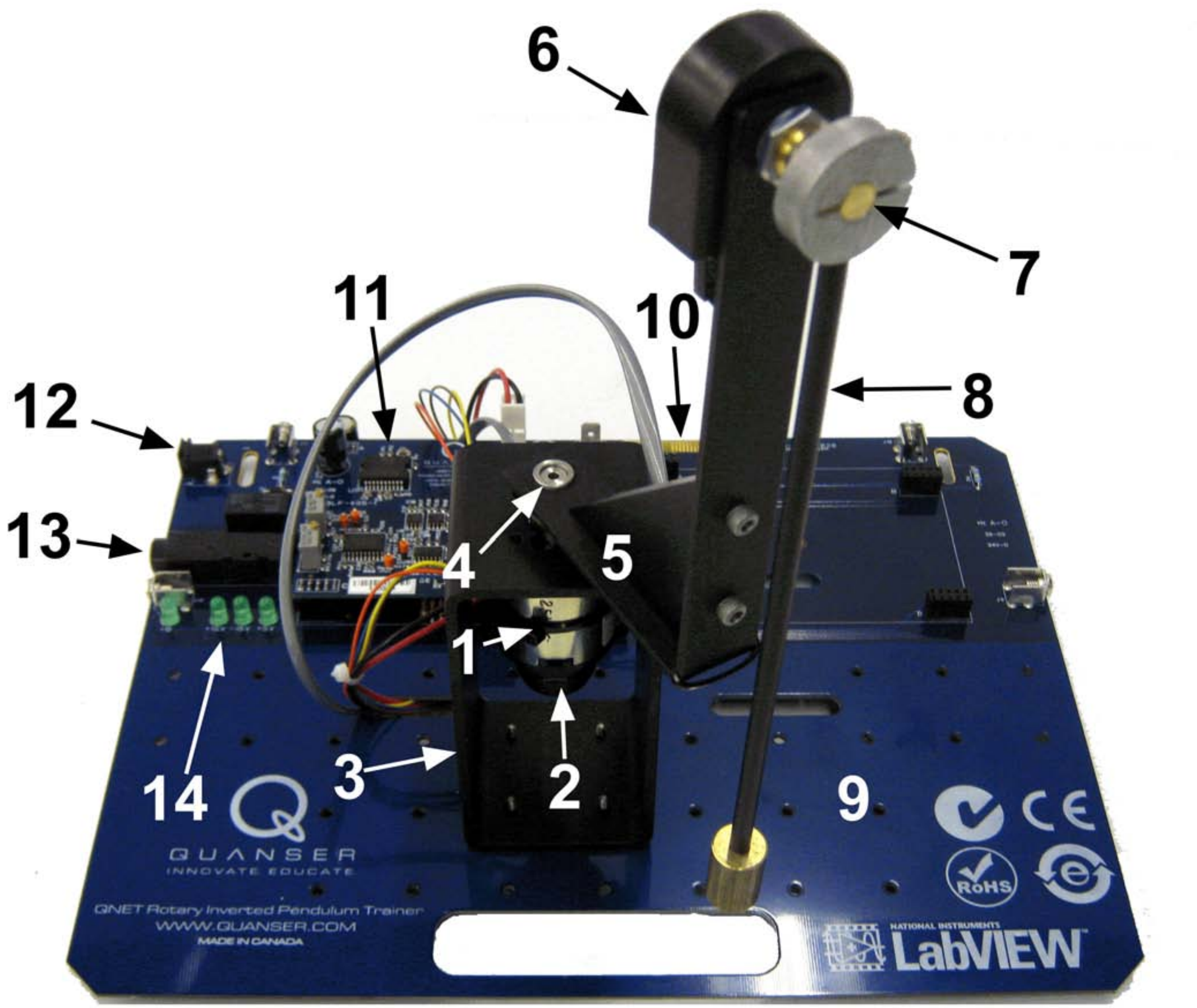

Figure 18: General layout of QNET ROTPENT.

The ROTPENT components in Figure 18 and Figure 19 are located and identified by a unique ID in Table 12.

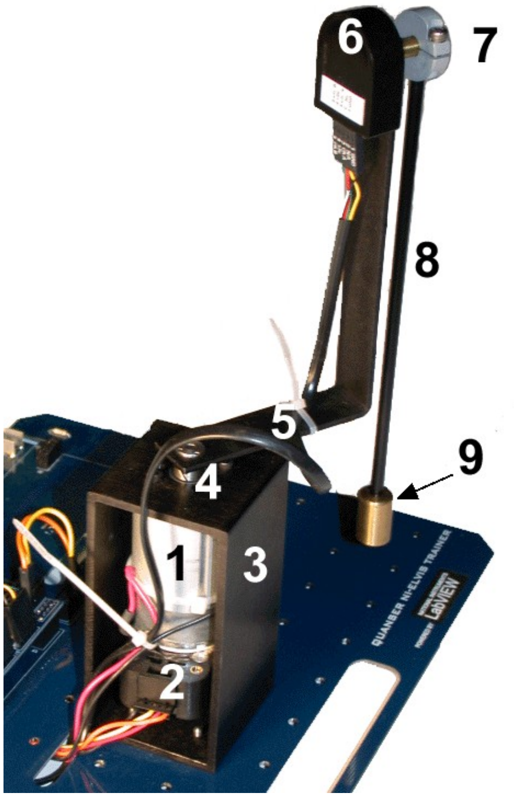

Figure 19: Components of QNET-ROTPENT pendulum assembly.

ID #	Description	ID #	Description
1	DC motor	8	Pendulum link
2	High-resolution encoder that measured arm angle	9	Pendulum weight
3	Motor metal chamber	10	PCI connector to NI ELVIS: for interfacing QNET module with DAC.
4	Rotary arm pivot	11	QNET PWM/Encoder board
5	Rotary arm	12	24V QNET power jack
6	Pendulum encoder	13	Fuse
7	Pendulum pivot	14	+B, +15V, -15V, +5V LEDs

Table 12: ROTPENT component nomenclature.

5.2. System Schematic

A schematic of the ROTPENT system interfaced with a DAQ device is provided in Figure 20.

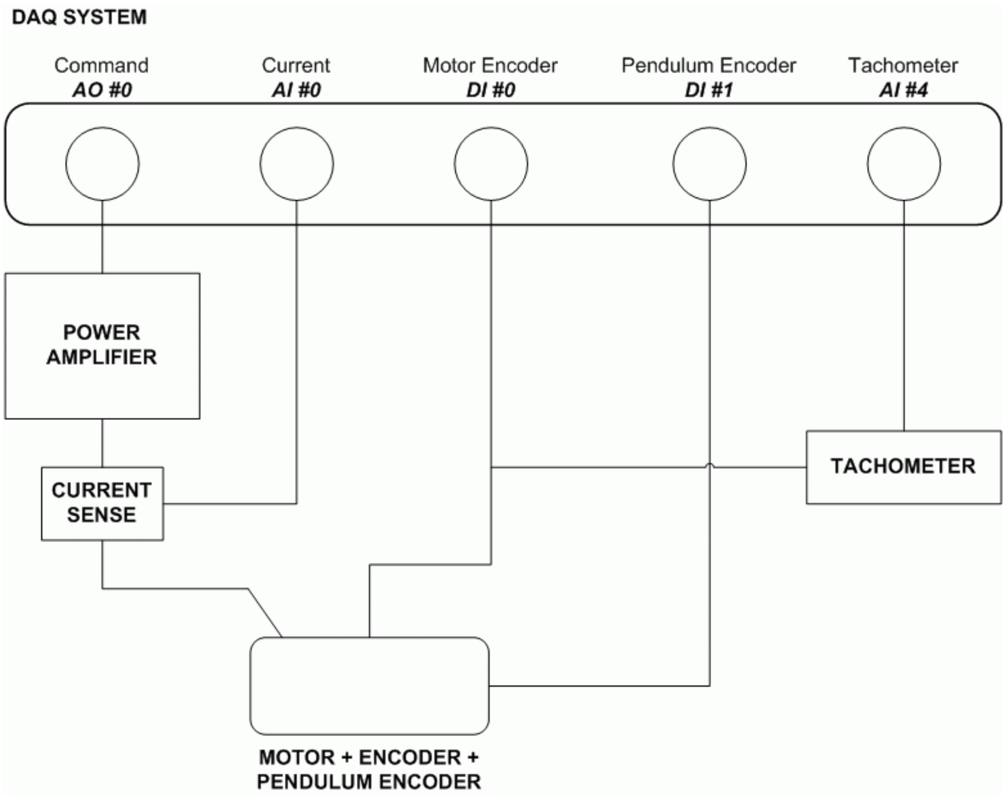

Figure 20: Schematic of QNET-ROTPEN system.

5.3. Component Description

This Section provides a description of the individual elements comprising the rotary pendulum trainer system.

5.3.1. DC Motor

The 12-Volt DC motor has 5 commutator segments, 64 windings per pole, and has a flux ring. The Coulomb friction of the motor corresponds to a voltage between 0.5 and 1.5 V.

5.3.2. Pulse-Width Modulated Power Amplifier

A PWM power amplifier is used to drive the motor. The input to the amplifier is the output of the Digital-to-Analog converter (i.e. D/A) of channel #0 on the DAQ. The maximum output voltage of the amplifier is 24 V. Its maximum peak current is 5 A and the maximum continuous current is 4 A. The amplifier gain is 2.3 V/V.

5.3.3. Analog Current Measurement: Current Sense Resistor

A series load resistor of 0.1 Ohms is connected to the output of the PWM amplifier. The signal is amplified internally to result in a sensitivity of 1.0 V/A. The obtained current measurement signal is available at the Analog-to-Digital (i.e. A/D) of channel #0. Such a current measurement can be used to

monitor the current running in the motor.

5.3.4. Digital Position Measurement: Optical Encoder

Digital position measurement is obtained by using a high-resolution quadrature optical encoder. There is one optical encoder directly mounted to the rear of the motor and another that measured the pendulum pivot angle. The motor encoder count measurement is available at Digital Input (i.e. DI) channel #0 on the DAQB and the pendulum encoder count is available at DI#1 on the DAQB .

5.3.5. Analog Speed Measurement: Tachometer

An analog signal proportional to motor speed is available at the Analog-to-Digital (i.e. A/D) Input channel #4 of the DAQ. It is digitally derived from the encoder signal on the QNET board.

5.3.6. Fuse

The QNET power amplifier has a 250 V, 3 A fuse.

5.3.7. QNET Power Supply

The ROTPENT module has a 24-Volt DC power jack to power the on-board PWM amplifier. It is called the QNET power supply. The +B LED on the QNET board turns bright green when the amplifier is powered.

CAUTION: Please make sure you use the correct type of wall transformer or you will damage the system. It should supply 24 VDC and be rated at 3.0 A.

5.4. Specifications

The specifications of the ROTPENT system model parameters are given in Table 13.

Symbol	*Description* *Motor:*	*Value*	*Unit*
R_m	Motor armature resistance.	8.7	ohms
K_t	Motor torque constant.	0.03334	N.m
K_m	Motor back-emf constant (same as K_t in SI units).	0.03334	V/(rad/s)
J_m	Moment of inertia of motor rotor.	1.80E-006	kg.m^2
J_{eq}	Equivalent moment of inertia about motor shaft pivot axis with pendulum assembly.	1.84E-004	kg.m^2
	Motor maximum continuous torque	0.10	N.m
	Motor maximum power rating	20.0	W
	Motor maximum continuous current	1.0	A

	Pendulum Arm:		
M_{arm}	Mass of the arm.	0.08	kg
r	Length of arm pivot to pendulum pivot.	0.0826	m
B_{eq}	Arm viscous damping.	0.000	N.m/(rad/s)
	Pendulum Link:		
M_p	Mass of the pendulum link and weight combined.	0.0270	kg
L_p	Total length of pendulum.	0.191	m
l_p	Length of pendulum center of mass from pivot.	0.153	m
M_{p1}	Mass of the pendulum link.	0.008	kg
M_{p2}	Mass of the pendulum weight.	0.019	kg
L_{p1}	Length of pendulum link.	0.171	m
L_{p2}	Length of pendulum weight.	0.190	m
J_p	Pendulum moment of inertia about its pivot axis.	1.70E-04	$kg.m^2$
B_p	Pendulum viscous damping.	0.000	N.m/(rad/s)
	Pulse-Width Modulated Amplifier:		
V_{max}	PWM amplifier maximum output voltage	24	V
	PWM amplifier maximum output current	5	A
	PWM amplifier gain	2.3	V/V

Table 13: ROTPENT model parameter and PWM power amplifier specifications.

The viscous damping parameters of the pendulum, B_p, and of the arm, B_{eq}, are regarded as being negligible in this laboratory.

The specifications on the ROTPENT system sensors are given in Table 14.

Description	***Value***	***Unit***
Current Sense:		
Current calibration	1.0	A/V
Current sense resistor	0.1	ohms
Pendulum Encoder:		
Encoder line count	1024	lines/rev
Encoder resolution (in quadrature mode)	0.0879	deg/count
Encoder type	TTL	
Encoder signals	A,B	
Motor Encoder:		
Encoder line count	360	lines/rev
Encoder resolution (in quadrature mode)	0.25	deg/count
Encoder type	TTL	
Encoder signals	A,B	
Tachometer:		
Tachometer calibration at QNET A/D input	2987	RPM/V

Table 14: ROTPENT sensor parameter specifications.

5.5. Environmental

The QNET rotary pendulum control trainer environmental operating conditions are given in Table 15.

Description	***Value***	***Unit***
Operating temperature	15 to 35	°C
Humidity	20 to 90	%

Table 15: QNET rotary pendulum trainer environmental operating conditions.

CAUTION: Ensure the unit is operated under the temperature and humidity conditions given in Table 15. Otherwise, there may be some issues with the running the experiments.

5.6. Assembly

Follow the instructions below to setup the QNET Rotary Pendulum trainer for experimental use.

1. The ROTPENT device comes disassembled as pictured in Figure 21, below.

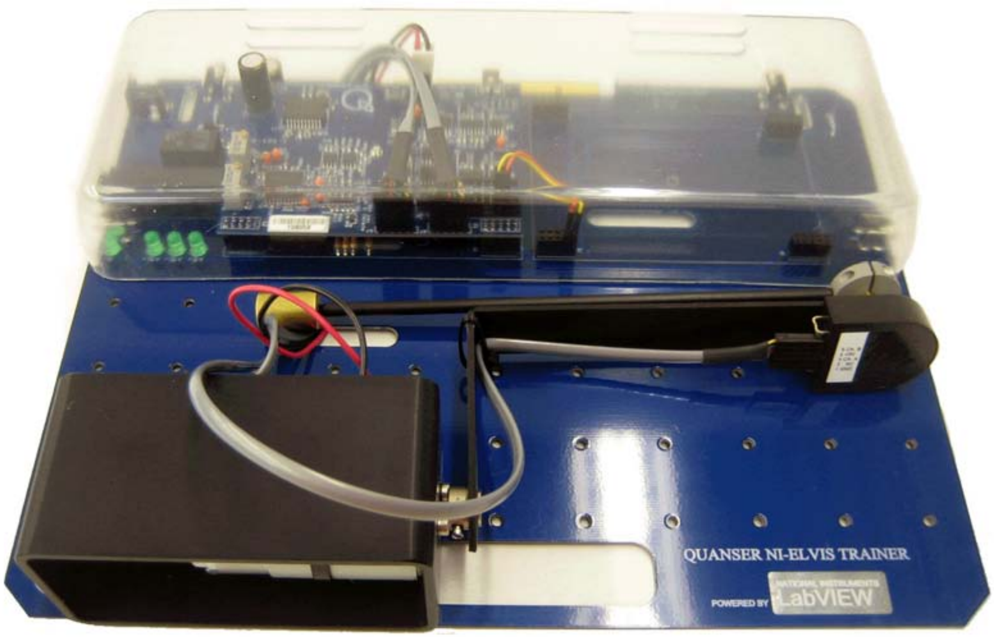

Figure 21: Disassembled QNET-ROTPENT.

2. Remove the thumbscrews from the bottom of the DC motor chamber.
3. Align the four screw holes on the bottom of the chassis with four holes on the QNET base. The ROTPEN should be upright similarly as shown in Figure 22.

Figure 22: Place the QNET-ROTPENT upright on the module and align screw holes.

4. Tighten the four thumbscrews from the bottom of the QNET module board though the DC motor chamber. This is pictured below in Figure 23.

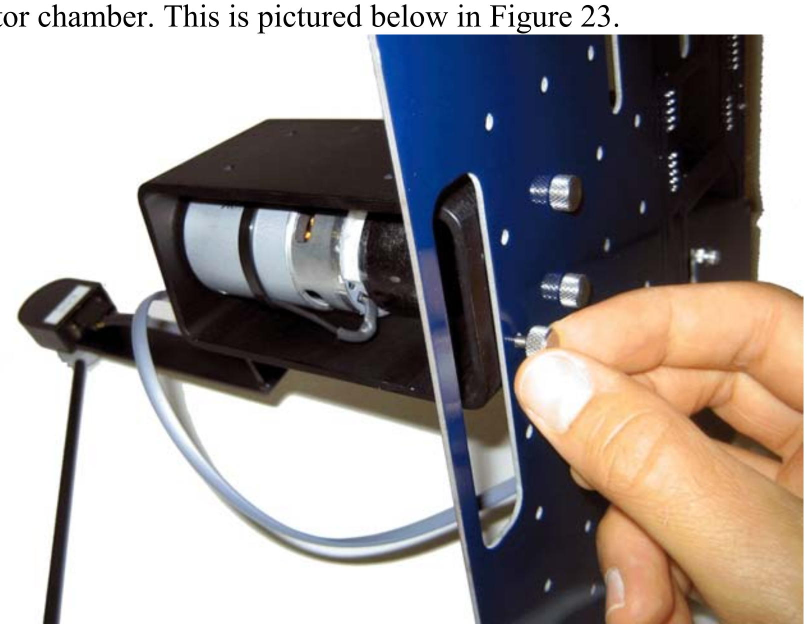

Figure 23: Tighten four thumbscrews.

5. The final system should look similarly as shown in Figure 18, above.

6. QNET-MECHKIT

6.1. General Overview

The photograph in Figure 24 shows an overview and the general layout of the QNET mechatronic sensors trainer (MECHKIT) system.

CAUTION: Ensure the MECHKIT trainer is setup as dictated in Section 2 and used as described in the Reference [1]. The MECHKIT trainer is susceptible to protection impairment if not used as specified.

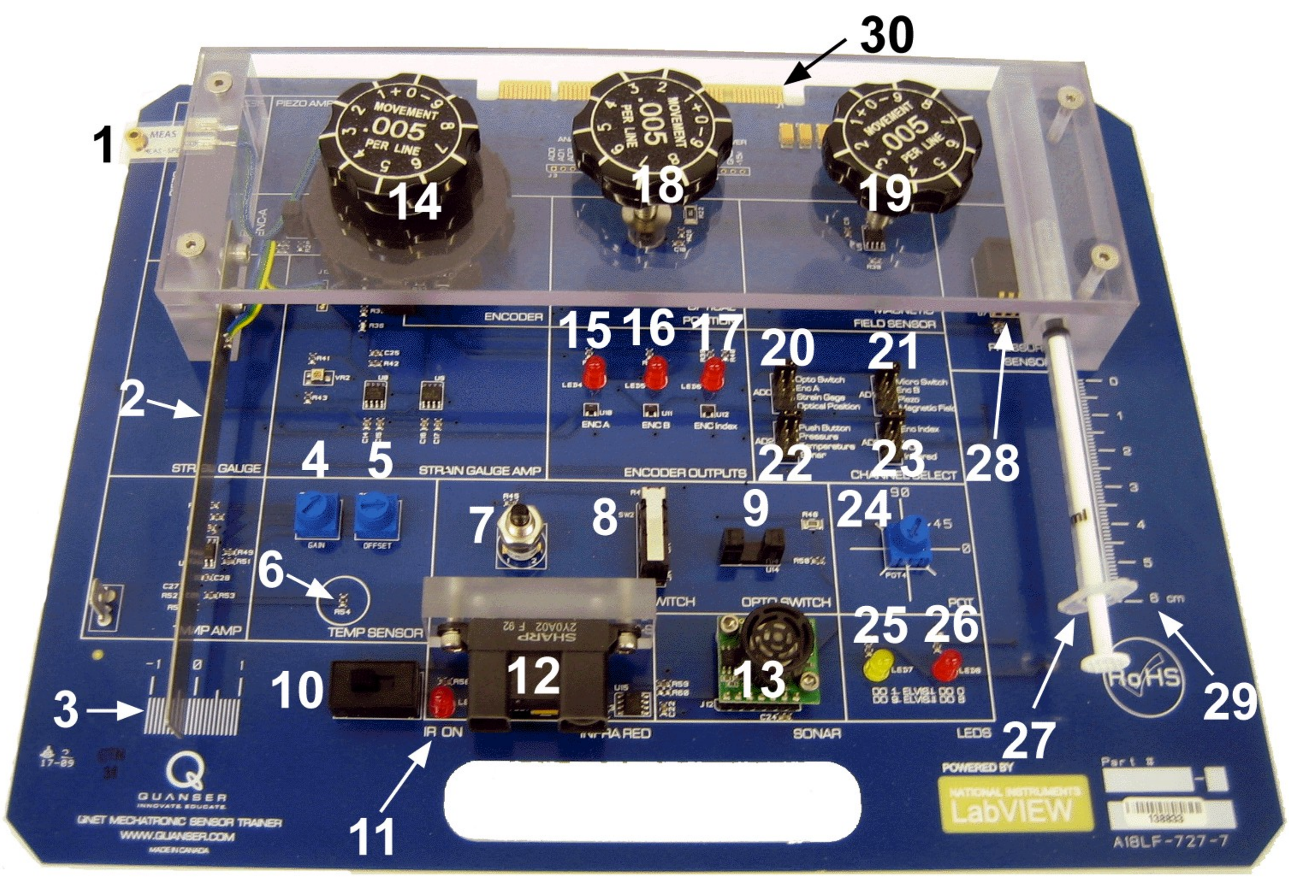

Figure 24: General layout of QNET mechatronics sensors trainer.

The MECHKIT components in Figure 24, above, are located and identified by a unique ID in Table 16.

ID #	Description	ID #	Description
1	Piezo Sensor	16	Enc B LED
2	Flexible link (connected to strain gage)	17	Enc Index LED
3	Flexible link ruler	18	Optical position sensor knob
4	Temperature sensor gain potentiometer	19	Magnetic field sensor knob
5	Temperature sensor offset potentiometer	20	AD0 Jumper
6	Thermistor	21	AD1 Jumper
7	Push button	22	AD2 Jumper
8	Micro switch	23	AD5 Jumper
9	Optical switch	24	Potentiometer
10	Infrared sensor on/off switch	25	DO 1 LED
11	Infrared sensor on/off LED	26	DO 0 LED
12	Infrared sensor	27	Plunger (connected to pressure sensor)
13	Sonar sensor	28	Pressure sensor
14	Encoder knob	29	Plunger ruler
15	Enc A LED	30	PCI connector to NI ELVIS: for interfacing QNET module with DAC.

Table 16: MECHKIT component nomenclature.

6.2. System Schematic

A schematic of the MECHKIT system interfaced with a DAQ device is provided in Figure 25.

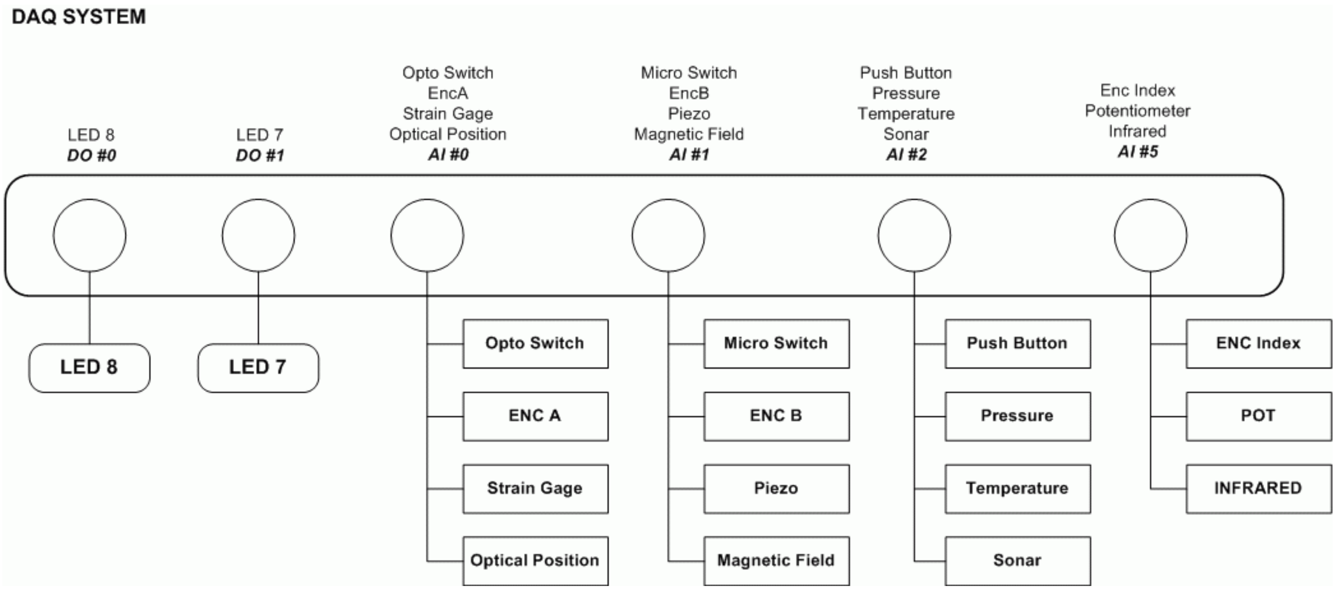

Figure 25: Schematic of QNET-MECHKIT system.

Remark: The Digital Output channels for the LEDs are different on the ELVIS I. On the ELVIS I, LED 8 is connected to DO #8 and LED 7 is connected to DO #9.

6.3. Component Description

6.3.1. Strain Gage

The strain gage is mounted on the flexible link and outputs a voltage ranging between +/- 5.0 V relative to the amount of deflection.

6.3.2. Piezo

The piezo is a flexible component that includes a piezoelectric polymer film that is laminated to a polyester substrate. The laminated strip contains an added mass at the end weighing 0.78 g. See Table 17 for sensitivity and resonance specifications.

6.3.3. Pressure

As outlined in Table 17, the pressure transducer on the QNET mechatronic sensors trainer has a range of 0-30 PSI, a sensitivity of 0.133 V/PSI, and outputs a voltage between 0.5-4.5 V. Thus it has a zero pressure offset of 0.5 V and a full-scale span of 4.5 V.

6.3.4. Thermistor

The thermistor is the in the circuit shown in Figure 26 and is the component labeled by *R*. The *Gain* and *Offset* components represent the potentiometer knobs on the QNET mechatronic sensors trainer. The *Offset* changes the offset of the input offset voltage, v_i, and the *Gain* changes the value of the amplifier gain, A_v.

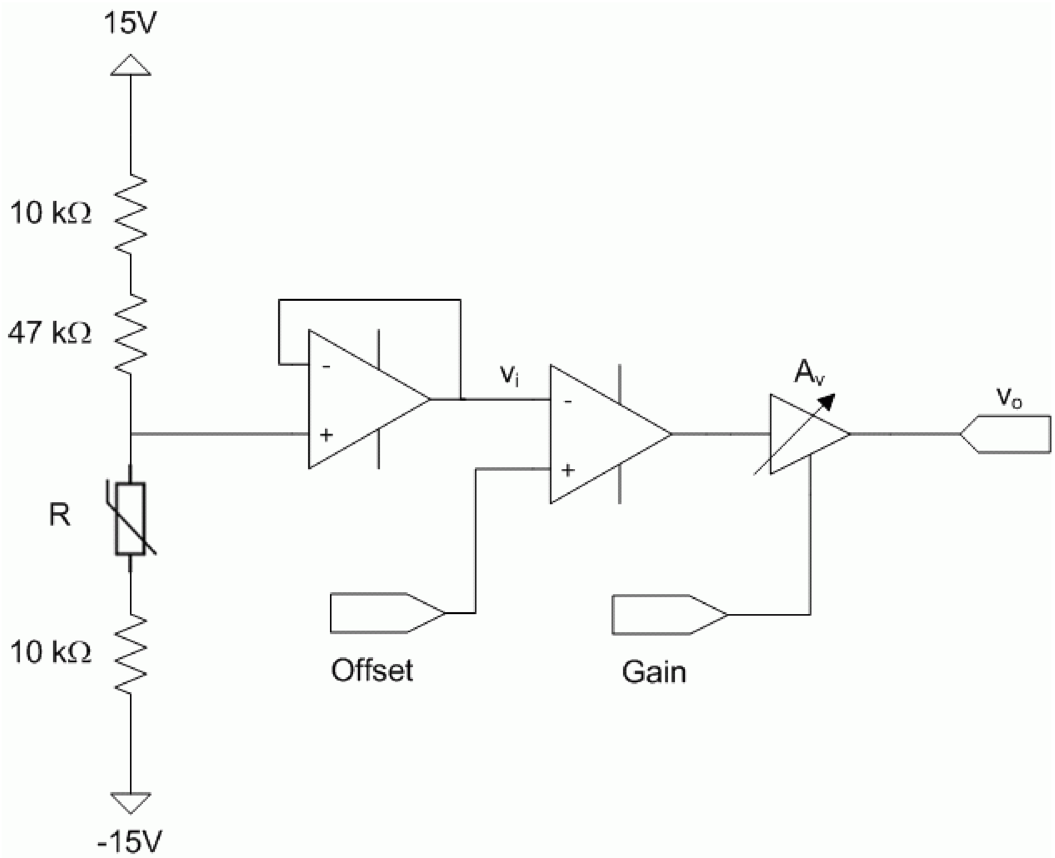

Figure 26: Thermistor circuit on QNET mechatronic sensors trainer.

6.3.5. Sonar

The sonar range finder device on the QNET MECHKIT has a operating measuring range of 6-254 inches and a resolution of 1-inch. It can detect objects in the range of 0-254 inches. The sonar sensor specifications are listed in Table 17.

6.3.6. Infrared

The infrared distance measuring unit uses a triangulation method to detect the distance of an object and has a distance measuring range of 20-150 cm, as given in Table 17. It outputs a voltage that correlates to the distance of the target.

6.3.7. Magnetic field

The linear magnetic field transducer on the QNET mechatronic sensors trainer outputs a voltage that is proportional to the magnetic field that is applied perpendicularly to the object being measured. The relationship, however, between the output voltage and the target distance is exponential.

6.3.8. Optical Position

The optical position sensor on the QNET MECHKIT board consists of an infrared emitting diode and a silicon photo-transistor, both mounted side by side. The range of the optical position sensor on the QNET MECHKIT is 0.25 inches, as given in Table 17.

6.3.9. Rotary potentiometer

The rotary potentiometer outputs a voltage that varies linearly with the angle being measured. As listed in Table 17, the potentiometer has a mechanical limit of 300 degrees.

6.3.10. Encoder

The encoder knob is fitted onto a spindle with 9 teeth. As spindle is rotates, the teeth go through two optical switches and generate the encoder A and B signals. The index pulse is generated by a magnetic pickup sensor.

6.3.11. Micro Switch

The analog input line connected to the miniature snap action switch is pulled high, to +5V, when the switch is in open position and goes down to low when pressed down. The micro switch circuit is depicted in Figure 27.

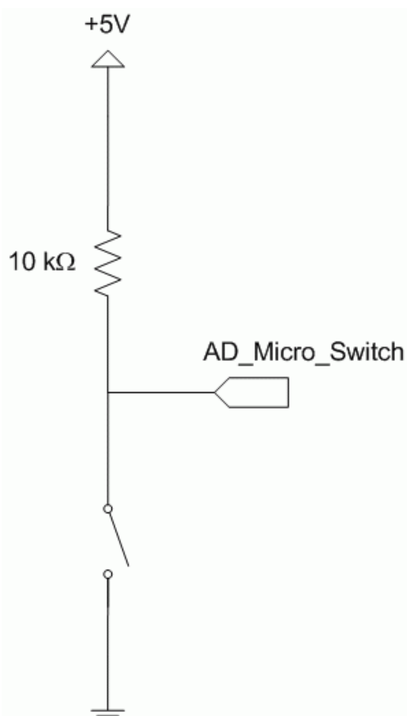

Figure 27: Micro switch circuit.

6.3.12. Push Button

The push button analog line goes to +5V when the button is pressed down, i.e. when the switch is

closed. Its circuit is shown in Figure 28, below.

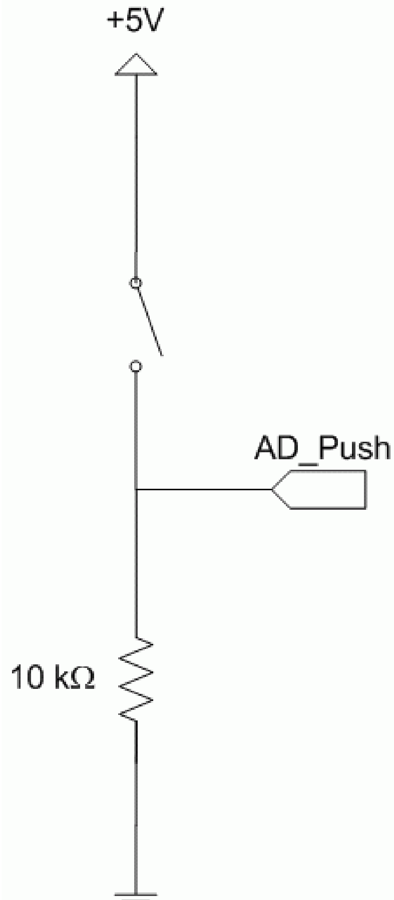

Figure 28: Push button circuit.

6.3.13. Optical Switch

The optical switch is a photo-microsensor that consists of a transmissive and a reflective component. If an object is placed between the components and the reflective sensor does not sense any light, the output goes high to +5V. The switch outputs 0V when no object is detected.

6.3.14. Light Emitting Diodes

The yellow light emitting diode, LED 7, is connected to Digital Output #9 on the ELVIS II and DO#1 on ELVIS I. The red LED, LED 8, is connected to Digital Output #8 on the ELVIS II and DO#0 on ELVIS I. The yellow LED is active high whereas the red LED is active low.

6.4. Specifications

Some of the sensor specifications for the MECHKIT are given in Table 17.

Description	***Value***	***Unit***
Potentiometer		
Mechanical angle range	300.000	deg
Independent linearity	+/-5	%
Infrared Sensor		
Distance measuring range	20 to 150	cm
Pressure Sensor		
Pressure range	0-30	PSI
Sensitivity	0.133	V/PSI
Output range	0.5-4.5	V
Quantization step	3.0	mV
Accuracy	+/-2	%Vs
Sonar		
Object detection	0-254	in
Sonar range	6-254	in
Resolution	1.0	in
Reading frequency	20.0	Hz
Piezo Film		
Ring mass on film	0.72	g
Location of mass from edge	1.40	cm
For 0.78 g added mass:		
Sensitivity at resonance	16.0	V/g
Resonant frequency	40.0	Hz
3 dB frequency	20.0	Hz
Optical Position		
Range	0.25	in

Table 17: MECHKIT Specifications

7. QNET-VTOL

7.1. General Overview

The pictures in Figure 29 and Figure 30 show the general layout of the QNET vertical take-off and landing trainer.

CAUTION: Ensure the VTOL trainer is setup as dictated in Section 2 and used as described in the Reference [1]. The VTOL trainer is susceptible to protection impairment if not used as specified.

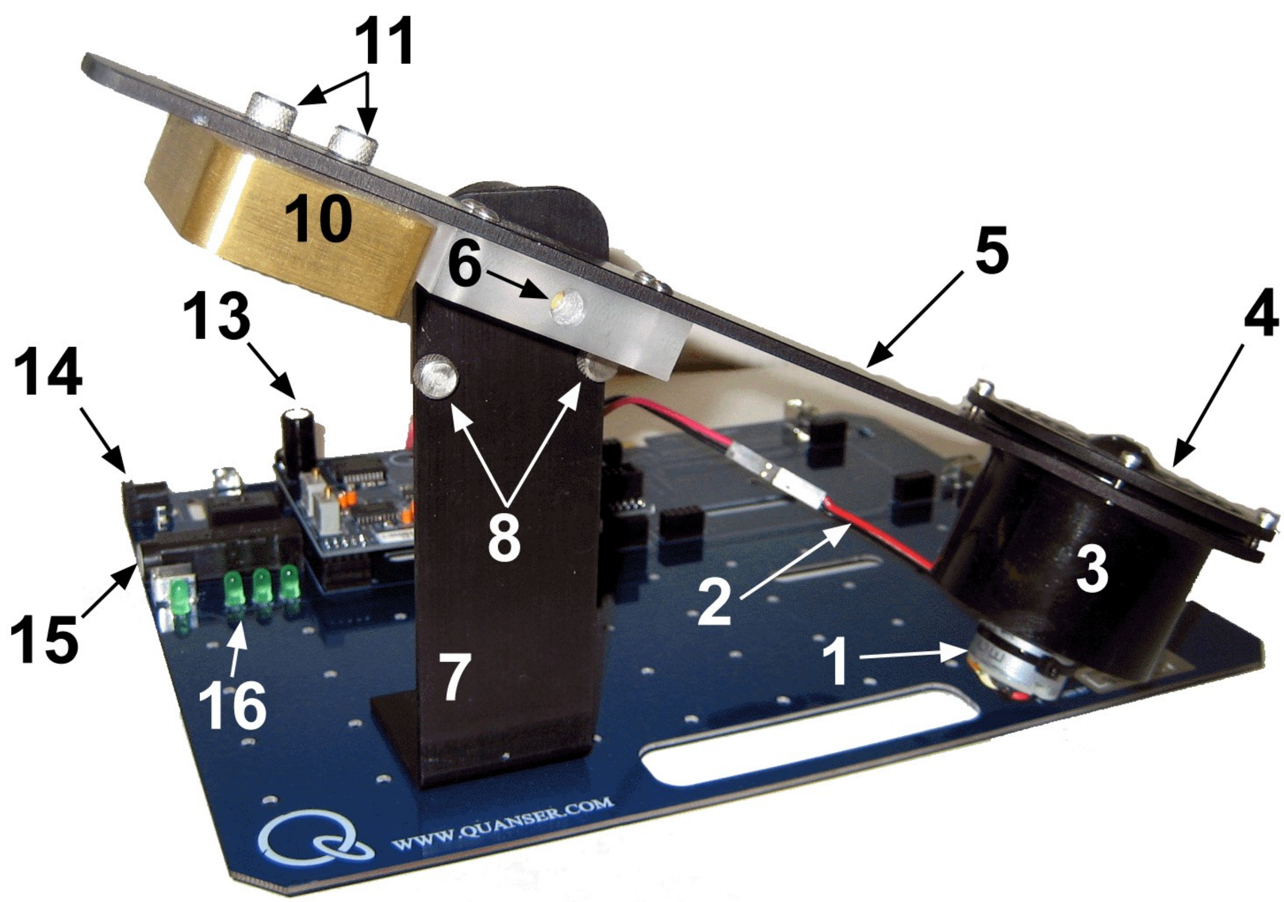

Figure 29: Front view of VTOL layout.

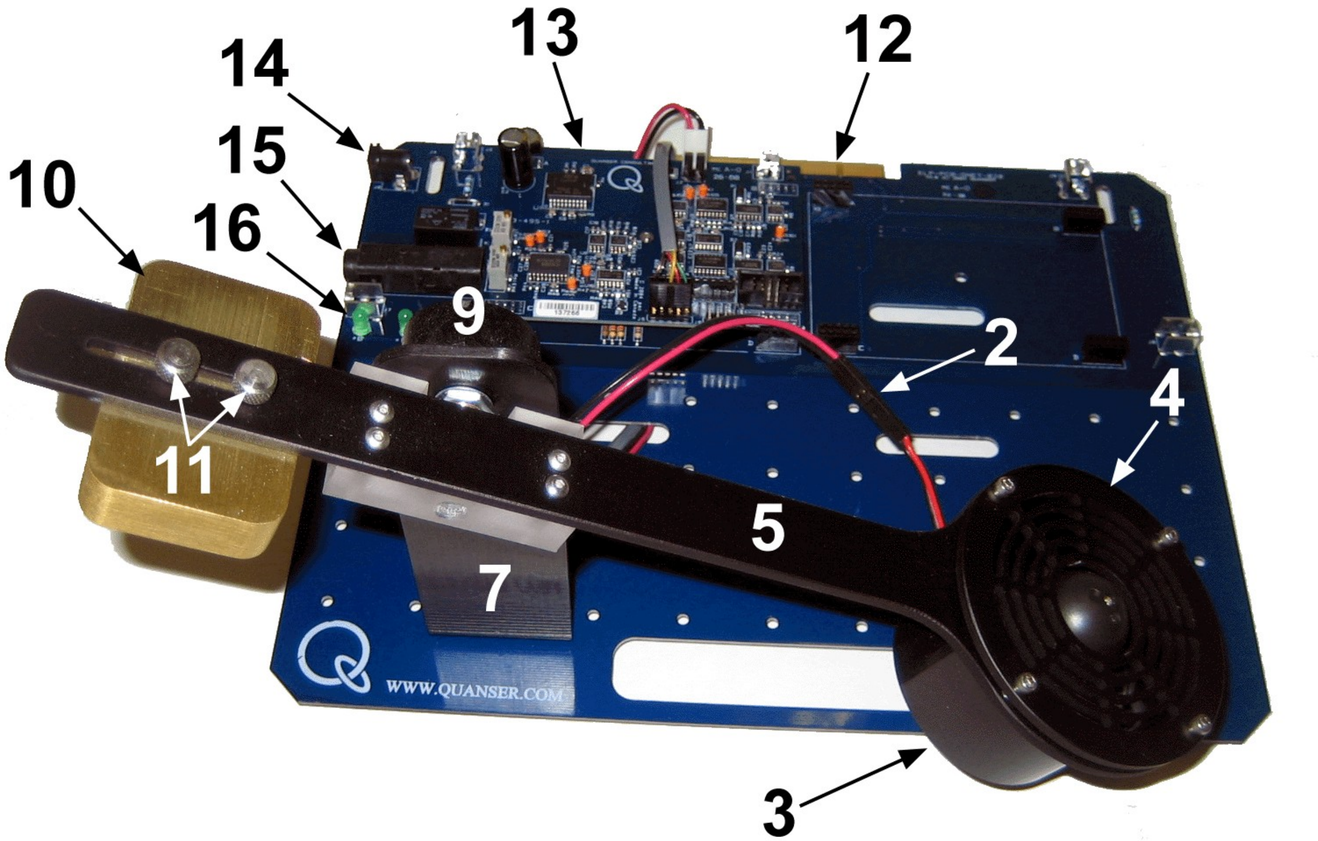

Figure 30: Top view of VTOL layout.

The VTOL components in Figure 29 and Figure 30 are located and identified by unique ID in Table 18.

ID #	Description	ID #	Description
1	DC Motor	9	Encoder
2	Motor leads (connects amplifier to motor)	10	Counterweight
3	Propeller holder	11	Counterweight thumbscrews
4	Propeller shield	12	PCI connector to NI ELVIS: for interfacing QNET module with DAC.
5	VTOL body	13	QNET PWM/Encoder board
6	Pivot / encoder shaft	14	24V QNET power jack
7	Support arm	15	Fuse
8	Support thumbscrews	16	+B, +15V, -15V, +5V LEDs

Table 18: VTOL component nomenclature.

7.2. System Schematic

A schematic of the VTOL system interfaced with a DAQ device is provided in Figure 31.

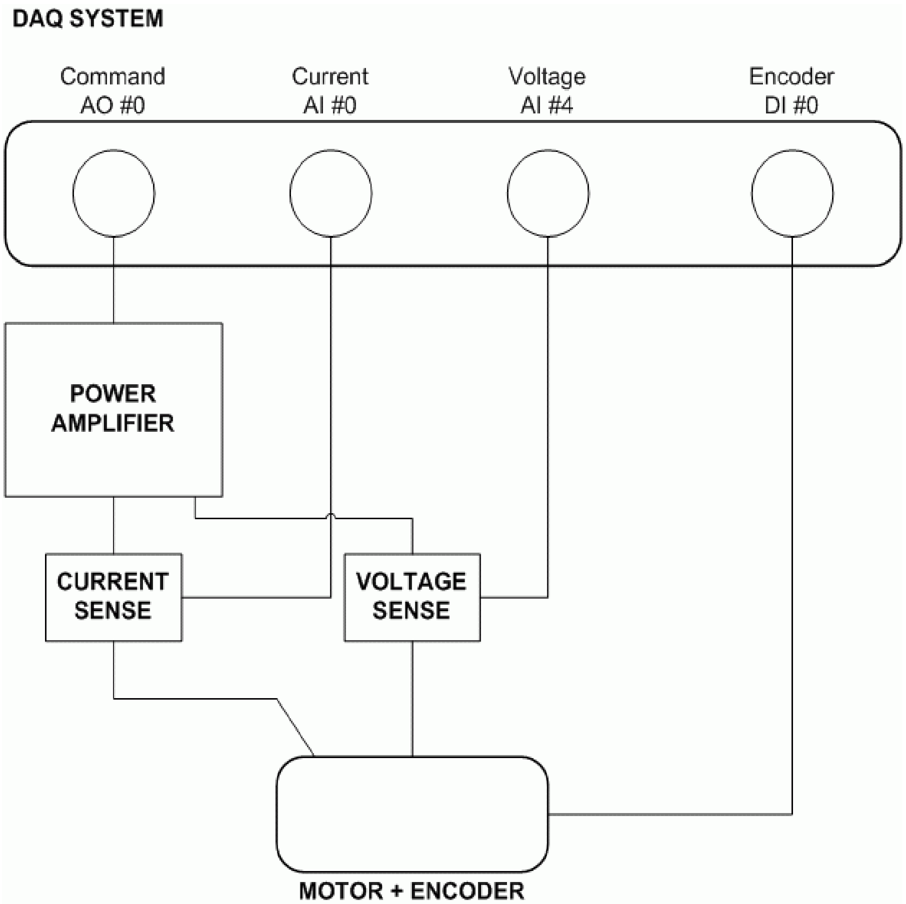

Figure 31: Schematic of QNET-VTOL system.

7.3. Component Description

7.3.1. Rotor Actuator

The *EM150* DC motor and the *EP2245X6* rotor have the specifications given in Table 19.

Volts (V)	*Amps (A)*	*Thrust (g)*	*Thrust (oz)*	*Power (W)*	*Efficiency (g/W)*	*Efficiency (oz/kW)*
3.6	1.5	32	1.13	5.4	5.93	209
4.8	2.2	50	1.76	10.56	4.73	167
6	3	77	2.72	18	4.28	151
7.2	3.8	95	3.35	27.36	3.47	122
8.4	4.8	119	4.2	40.32	2.95	104
9.6	5.9	141	4.97	56.64	2.49	88
10.8	6.6	152	5.36	71.28	2.13	75

Table 19: VTOL rotor specifications.

7.3.2. Pulse-Width Modulated Power Amplifier

A PWM power amplifier is used to drive the VTOL DC motor. The input to the amplifier is the output of the Digital-to-Analog converter (i.e. D/A) of channel #0 on the DAQ. The maximum output voltage of the amplifier is 24 V. Its maximum peak current is 5 A and the maximum continuous current is 4 A. The amplifier gain is 2.3 V/V.

7.3.3. Analog Current Measurement: Current Sense Resistor

A series load resistor of 0.1 Ohms is connected to the output of the PWM amplifier. The signal is amplified internally to result in a sensitivity of 1.0 V/A. The obtained current measurement signal is available at the Analog-to-Digital (i.e. A/D) of channel #0. Such a current measurement can be used to monitor the current in the heater.

7.3.4. Analog Voltage Measurement: Voltage Sense

The analog signal proportional to the voltage output of the PWM amplifier is available at the Analog-to-Digital (i.e. A/D) channel #4 of the DACB. The voltage sensor sensitivity is 3.33 V/V. Such a voltage measurement can be used to monitor the voltage applied to the heater.

7.3.5. Digital Position Measurement: Optical Encoder

Digital position measurement is obtained by using a high-resolution quadrature optical encoder. This optical encoder is mounted near the top of the VTOL support arm. The encoder shaft is used as the pivot of the VTOL body. The encoder count measurement is available at Digital Input (i.e. DI) channel #0 of the DAQ.

7.3.6. Fuse

The QNET power amplifier has a 250 V, 3 A fuse.

7.3.7. QNET Power Supply

The VTOL module has a 24-Volt DC power jack to power the on-board PWM amplifier. It is called the QNET power supply. The +B LED on the QNET board turns bright green when the amplifier is powered.

CAUTION: Please make sure you use the correct type of wall transformer or you will damage the system. It should supply 24 VDC and be rated at 3.0 A.

7.4. Specifications

The VTOL specifications listed in Table 20 include the various masses and lengths of the system as well as the viscous damping. Note that the viscous damping is estimated and will vary between different VTOL units.

Description	*Symbol*	*Value*	*Unit*
Propeller mass	m_1	0.068	kg
Counter-weight mass	m_2	0.27	kg
VTOL body mass	m_h	0.048	kg
Length from pivot to propeller center	l_1	15.6	cm
Length from pivot to center of counter-weight	l_2	5.6	cm
Total length of helicopter body.	L_h	28.4	cm
Estimated viscous damping of VTOL (this may vary from unit to unit).	B	0.002	N.m/(rad/s)

Table 20: VTOL Specifications

7.5. Environmental

The QNET VTOL environmental operating conditions are given in Table 21.

Description	*Value*	*Unit*
Operating temperature	15 to 35	°C
Humidity	20 to 90	%

Table 21: QNET-VTOL environmental operating conditions.

CAUTION: Ensure the unit is operated under the temperature and humidity conditions given in Table 21. Otherwise, there may be some issues with the experimental results.

7.6. Assembly

This section describes how to assemble the QNET Vertical Take-Off and Landing trainer. When fully assembled, it should appear as pictured Figure 39.

1. The VTOL trainer is shipped as shown Figure 32.

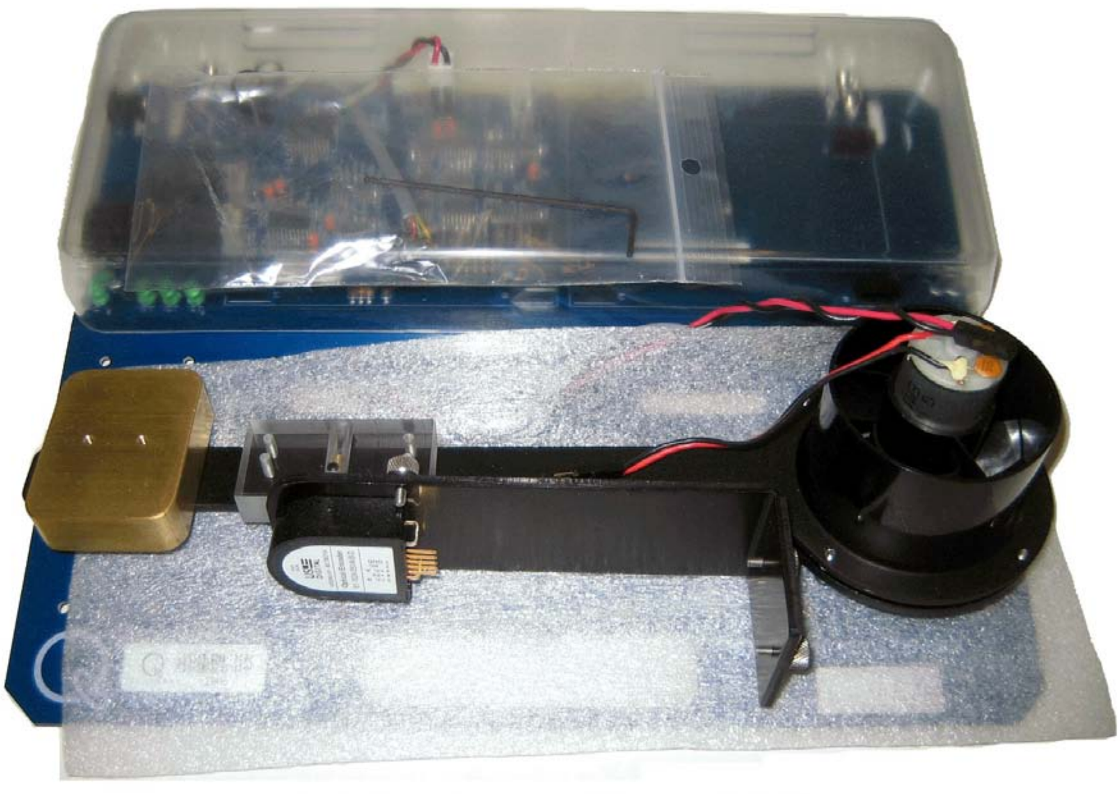

Figure 32: Disassembled VTOL.

2. Remove one of the thumbscrews located on the support arm, as depicted in Figure 33.

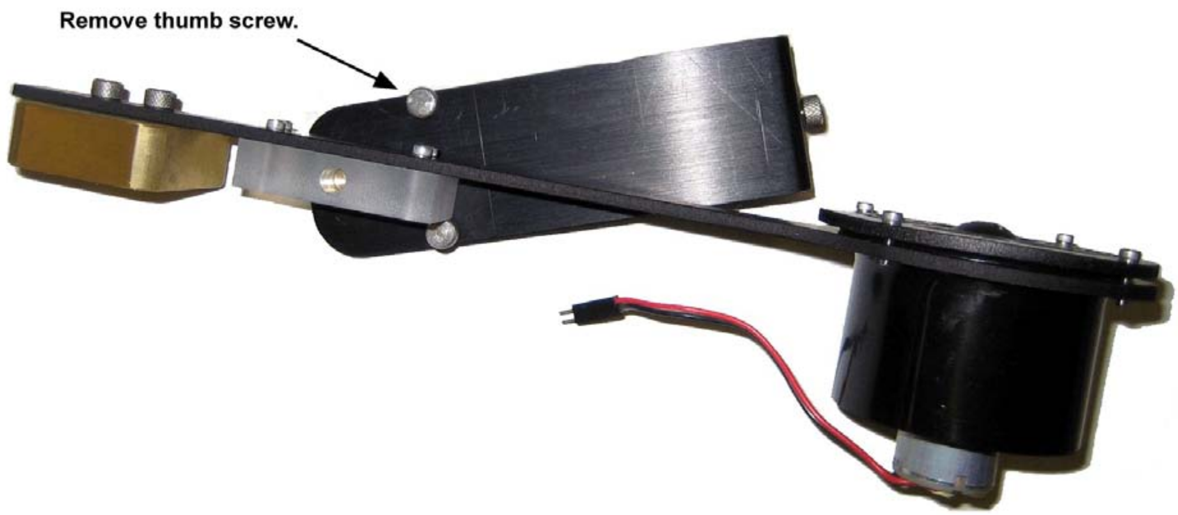

Figure 33: Remove thumbscrew on support arm.

3. As shown in Figure 34, rotate the VTOL body so both thumbscrews on the support arm are located underneath and re-tighten the thumbscrew that was removed in the previous step.

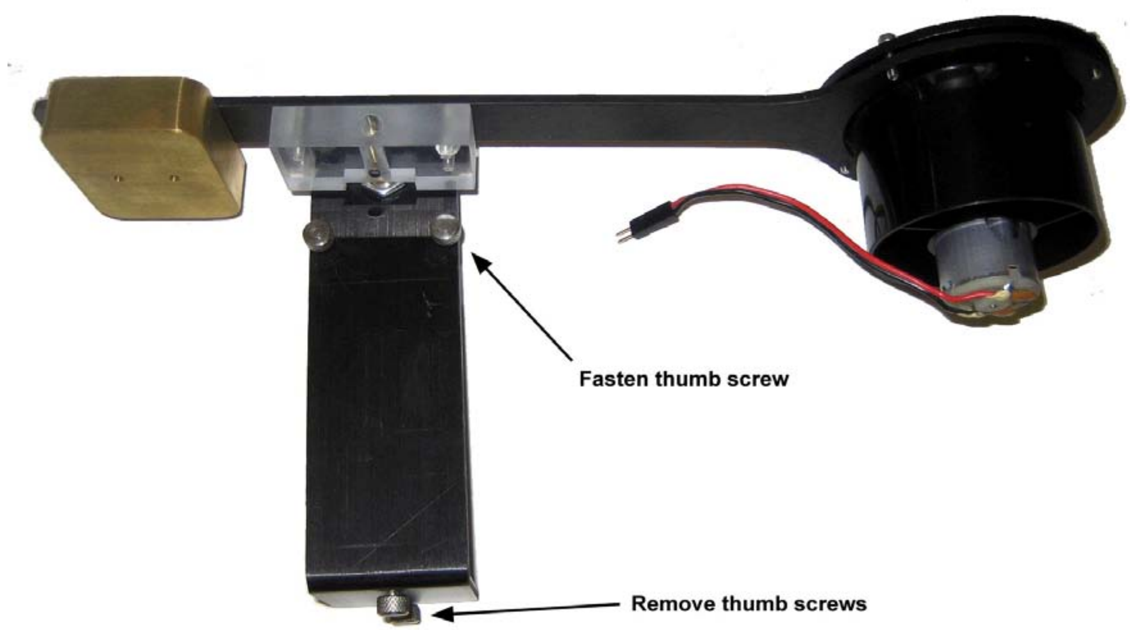

Figure 34: Re-tighten thumbscrew on support arm and remove the two bottom thumbscrews.

4. Remove the two thumbscrews located underneath the support. The bottom screws to be removed are shown above in Figure 34.
5. Bring the support arm in the upright position and align the two screw holes located on the base with two holes on the QNET module board. This is illustrated in Figure 35. Tighten the two supplied thumbscrews from the bottom of the module board to fasten the board onto the VTOL body base, as shown in Figure 36.

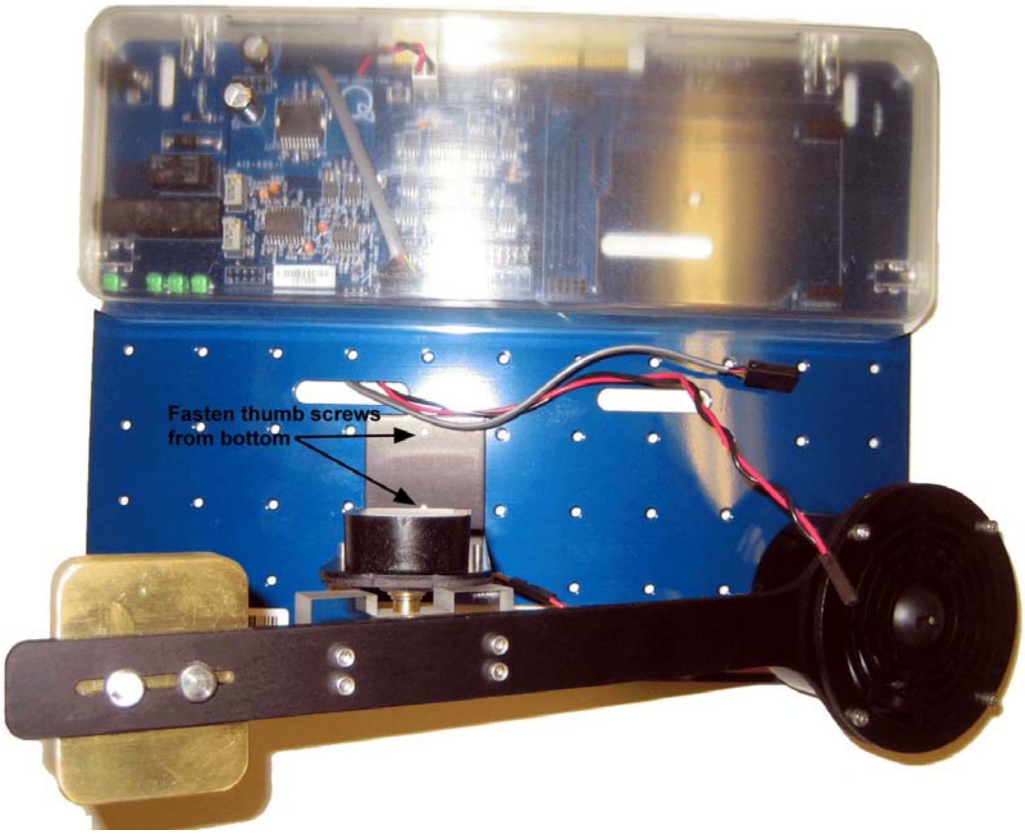

Figure 35: Tighten the two thumbscrews from the bottom of the module to the screw holes on the VTOL anchor base.

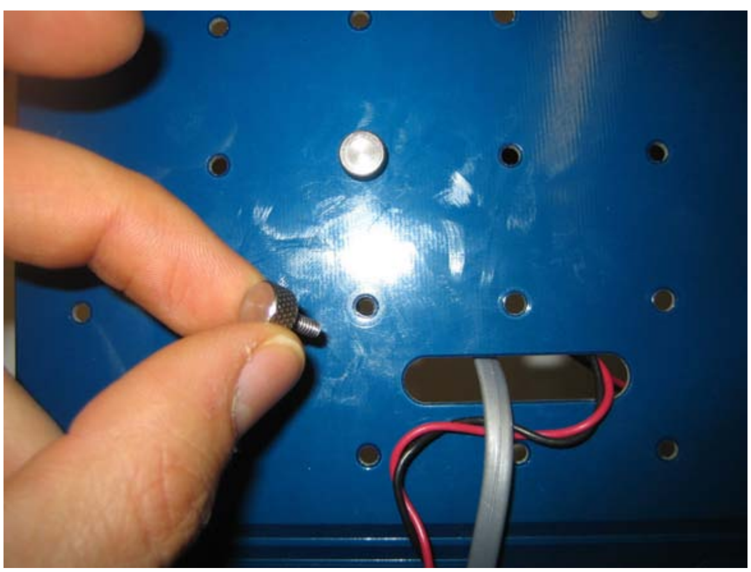

Figure 36: Tightening the two thumbscrews from the bottom of the module.

6. As demonstrated in Figure 37, connect the motor cable from the VTOL actuator to the wires from the QNET PWM/Encoder board. Make sure the red and black cables match.

CAUTION: Ensure the red and black wires are connected to each other.

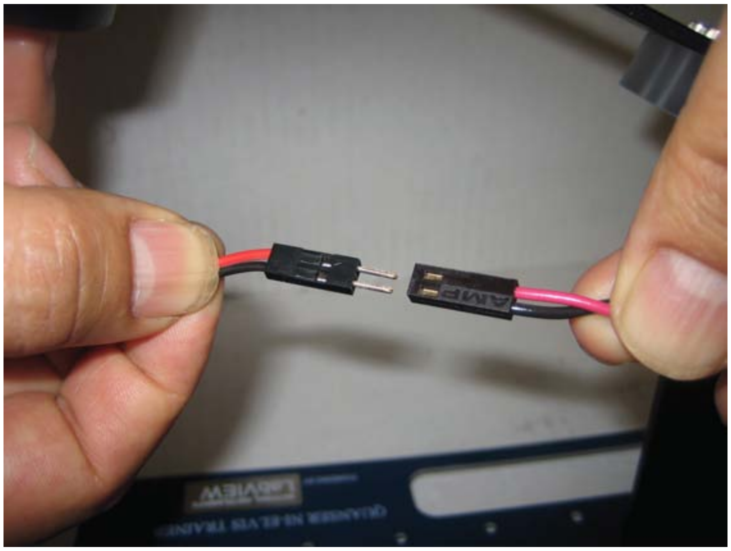

Figure 37: Connect motor cable.

7. Connect the encoder cable from the QNET PWM/Encoder board to the encoder connector on the VTOL, as shown in Figure 38.

CAUTION: Make sure the signals of the cable and encoder match, e.g. Ch. B on connector is connected to Ch. B on encoder.

Figure 38: Connect encoder cable.

8. The final assembly of the QNET-VTOL is shown in Figure 39. You can vary the position of the counter-weight at the end of the VTOL body. It is recommended to move the mass as far away from the propeller without actually lifting the propeller itself, i.e. it should still be resting on the QNET module.

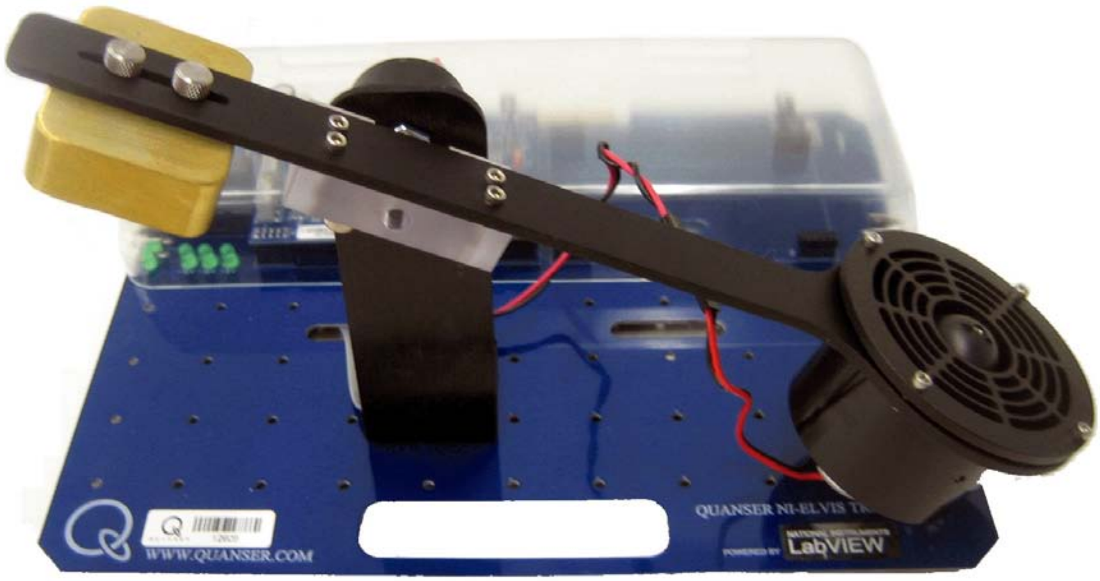

Figure 39: Fully assembled QNET-VTOL trainer.

8. MYOELECTRIC

8.1. General Overview

The photograph in Figure 40 shows an overview and the general layout of the QNET Myoelectric Trainer system.

CAUTION: Ensure the myoelectric trainer is setup as dictated in Section 2 and used as described in the Reference [1]. The myoelectric trainer is susceptible to protection impairment if not used as specified.

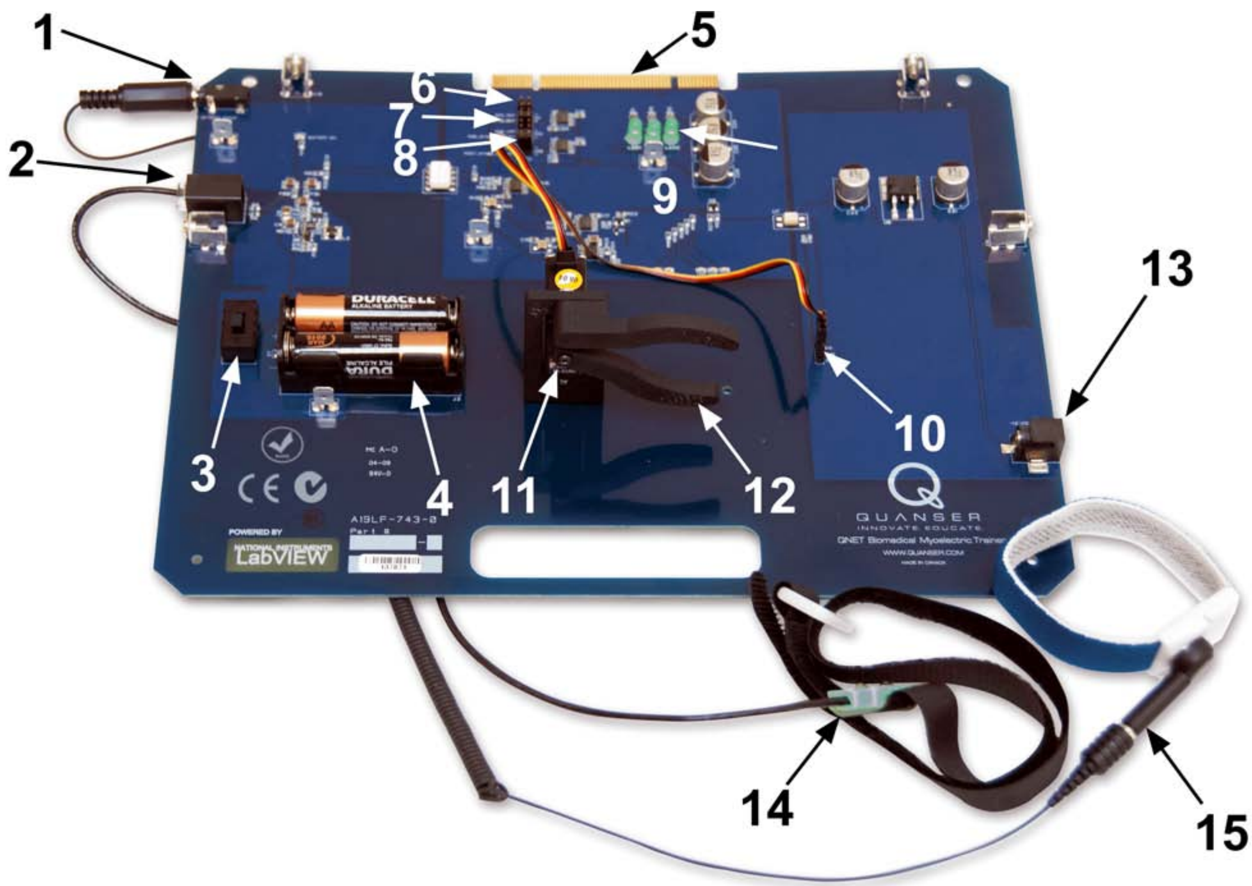

Figure 40: General layout of QNET Myoelectric trainer.

The Myoelectic components in Figure 40 are located and identified by a unique ID in Table 22.

ID #	Description	ID #	Description
1	Ground Strap Connector	9	+15V, -15V, +5V LEDs
2	EMG Sensor Connector	10	Servo Motor Connector
3	EMG Power On/Off SW2 Switch	11	Servo Motor
4	Battery Power Supply for EMG	12	Servo Clamps
5	PCI connector to NI ELVIS: for interfacing QNET module with DAC	13	24V QNET power jack
6	AD1 DIP Switch	14	EMG sensor strap
7	AD2 Dip Switch	15	Grounding strap
8	AD5 Dip Switch		

Table 22: Myoelectric component nomenclature.

8.2. System Schematic

A schematic of the QNET Myoelectric system interfaced with a DAQ device is illustrated in Figure 41. The block diagram representing the circuit in the Myoelectric board is shown in Figure 42.

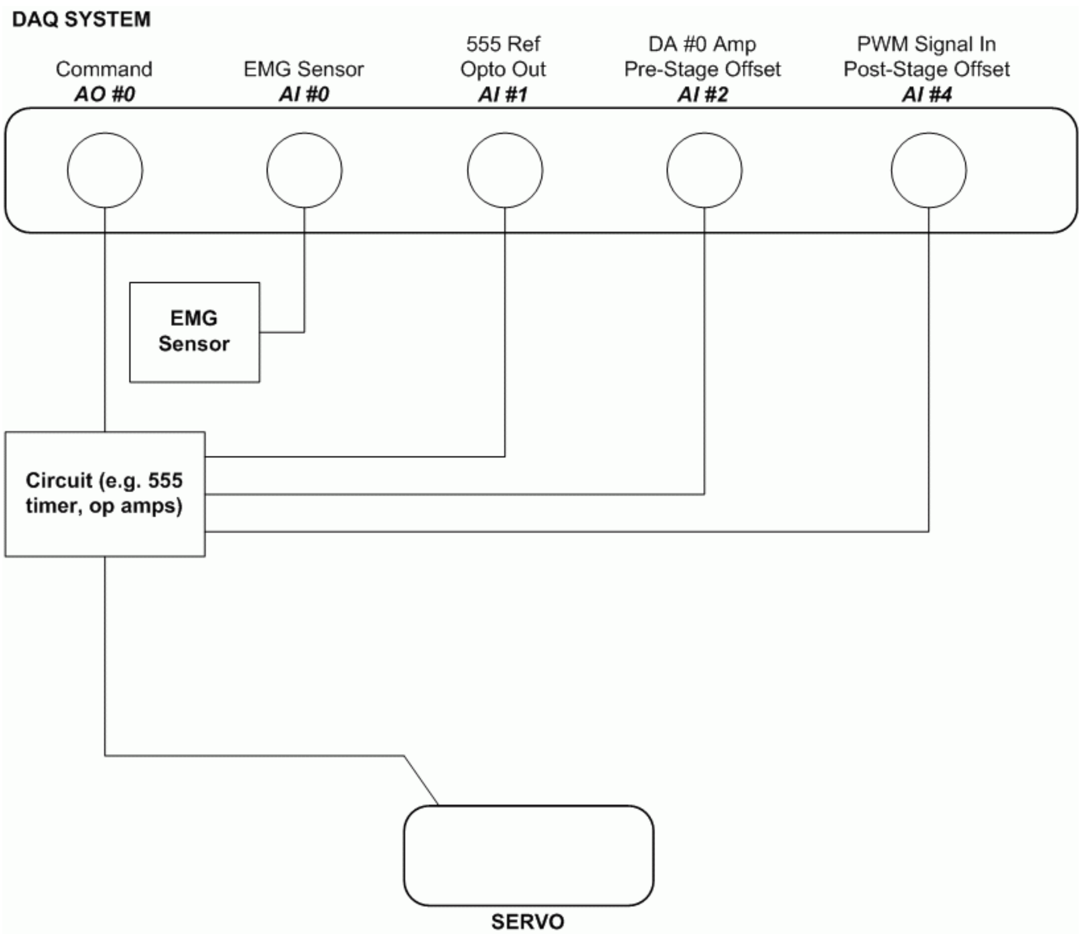

Figure 41: Schematic of QNET Myoelectric trainer.

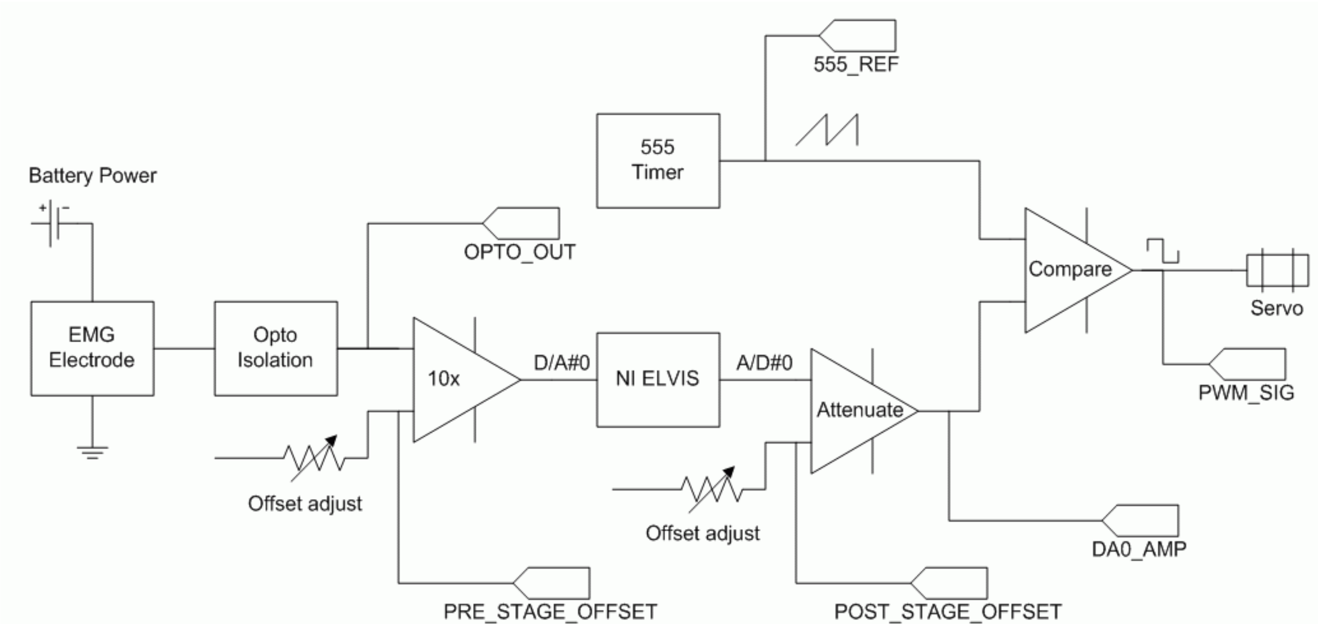

Figure 42: QNET Myolectric circuit block diagram.

8.3. Component Description

This section provides a description of the individual elements comprising the full DCMCT system.

8.3.1. Servo Motor

The servo motor supplied with the QNET Myoelectric trainer is controlled by a PWM signal and has an operating range of 4.8-6.0 V, as given in Table 23.

8.3.2. Isolation Amplifier

The HCPL-7800 optical isolation amplifier is used to amplify the electromyogram signal measured by the EMG electrode, remove noise, and isolate the power source from the user. See the Opto Isolation block in Figure 42. The amplifier has a gain of 8.0 V/V and its output voltage ranges between 1.29 V and 3.8 V. The output of the isolation amplifier can be measured on A/D #1 when the DIP switch is set to OPTO_OUT.

8.3.3. Muscle Contraction Measurement: EMG Sensor

The EMG Sensor consists of a two-electrode eletromyograph and a grounding strap with a ground electrode. It has an on-board gain of 300 V/V and a local band-pass filter with lower and upper cutoff frequencies of 25 Hz and 500 Hz, respectively. The electromyogram signal measured by the electromyograph relative to the ground terminal that is amplified by the isolation amplifier can be measured be measured on D/A #1 by setting the AD1 DIP switch to OPTO_OUT. The amplitude of the raw EMG signal is small and the signal is offset at around 2.5 V. As shown in Figure 42, the signal is then amplified to fit the +/- 10 V range and biased to 0 V. This *processed* signal is available on A/D #0 and is used to measure the amount of muscle contraction.

8.3.4. DIP Switches

The AD1, AD2, and AD5 DIP Switches dictate what signals can be measured on the Digital-to-Analog lines 1, 2, and 5, respectively. The AD1 DIP switch, components #6 shown in Figure 40, is used to measure the 555 timer or the output of the optical isolation circuit on D/A #1. As shown in Figure 42, the OPTO_OUT is the electromyogram signal that is measured by the EMG sensor and amplifier and offset by the isolation amplifier. It is offset by about 2.5 V. The 555 Timer resembles a sawtooth wave, but is more like an integrated pulse signal.

Use the AD2 DIP switch, ID #7 in Figure 40, to view either DA0_AMP or PRE_STAGE_OFFSET on D/A #2. The DA0_AMP signal is the processed Digital-to-Analog #0 channel output, as illustrated in Figure 42. This is the A/D #0 signal, i.e. the analog output signal supplied to DAQ, that is scaled down and offset by the post stage offset value before getting passed to the comparator. The PRE_STAGE_OFFSET is a constant value. It is the offset used to bring the EMG signal to be around 0 V.

The AD5 DIP switch, component #8 shown in Figure 40, determines what signal can be viewed on D/A #5 – PWM_SIG or POST_STAGE_OFFSET. The PWM_SIG is the pulse-width modulated signal being sent to the servo. It is the result of passing the 555 Timer pulse and the processed A/D#0 signal through a comparator. The POST_STAGE_OFFSET is the offset used to regulated the attenuated A/D#0 signal to be about 0 V.

8.3.5. 555 Timer

The National Semiconductor LM555CM-ND is a high-precision 555 timer integrated circuit that is used for the PWM cycles. It can be monitored on A/D#1 by setting AD1 DIP switch to 555_REF.

8.3.6. QNET Myoelectric Power Supply

The QNET Myoelectric trainer has a 12-Volt DC power jack to power the on-board ICs. It is called the QNET Myoelectric power supply.

CAUTION: Please make sure you use the correct type of wall transformer or you will damage the system. It should supply 12 VDC and be rated at 5.0 A. The QNET Myolectric does NOT use the same power supply as other QNET systems.

8.4. Specifications

The specifications of the QNET Myoelectic are given in Table 23.

Symbol	***Description*** ***Servo Motor:***	***Value***	***Unit***
	Operating Range	4.8-6.0	V

M_H	Stall torque	3	kg.cm
	Dimensions	29x13x30	mm^3
m_s	Weight	0.02	kg
	EMG Sensor:		
	Analog output range	+/-5	V
	Gain	300	V/V
	Upper cut-off frequency	500	Hz
	Lower cut-off frequency	25	Hz
	Common mode rejection ratio	80	dB
	Supply voltage (typical)	5.00	V
	Isolation Amplifier:		
V_{max}	Recommended input voltage (accurate and linear)	+/- 0.200	V
$\|V_{IN}+\|_{MAX}$	Maximum differential input voltage	0.308	V
G	Gain	8	V/V
V_{OL}	Output low voltage	1.29	V
V_{OH}	Output high voltage	3.8	V
	Bandwidth	100	kHz
	Supply Voltage	5.5	V

Table 23: Myoelectric specifications.

8.5. Environmental

The QNET Myoelectric environmental operating conditions are given in Table 24.

Description	*Value*	*Unit*
Operating temperature	15 to 35	°C
Humidity	20 to 90	%

Table 24: QNET Myoelectric trainer environmental operating conditions.

CAUTION: Ensure the unit is operated under the temperature and humidity conditions given in Table 24. Otherwise, there may be some issues with the experimental results.

9. QNET VI LabVIEW Hints

9.1. Scaling Scopes

This section describes a handy method of changing the *x* or *y* axis in a LabVIEW scope using *QNET_DCMCT_Swing_Up_Control* VI as an example. Read the steps below to reduce the y-axis range of the *Angle (deg)* scope shown in Figure 43 in order to see the blue trace more up close.

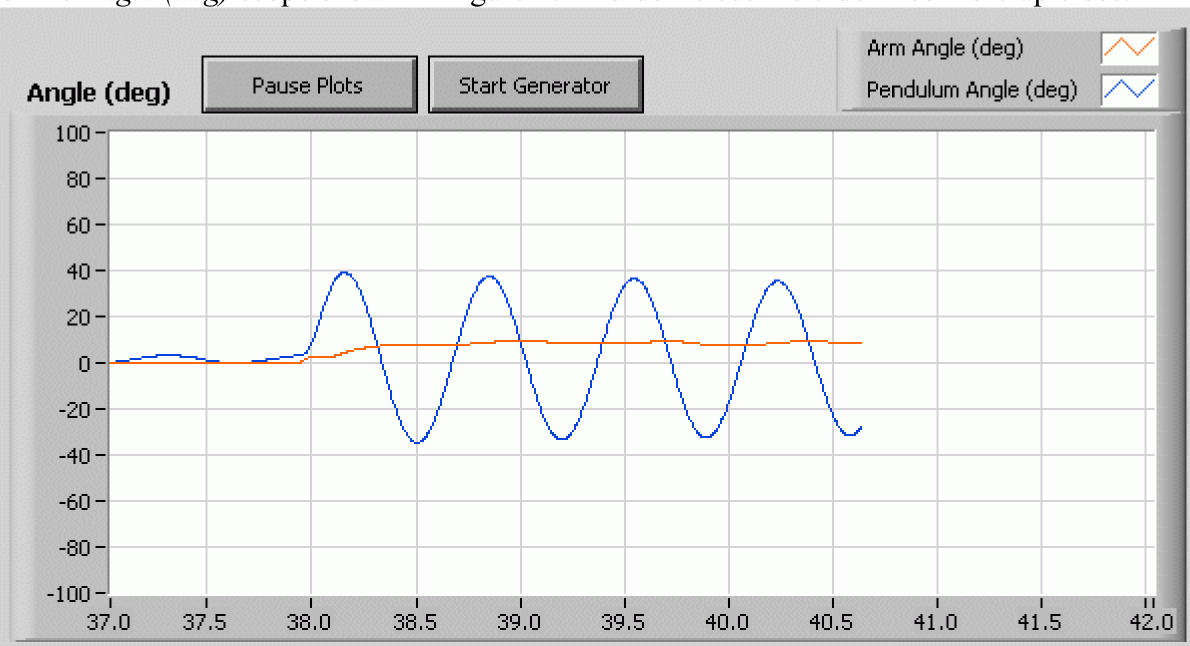

Figure 43: Scope needs to be scaled.

1. As illustrated in Figure 44, to decrease the positive range of the scope down to 40, double-click on '100' in the *y*-axis, type in '40', and press ENTER.

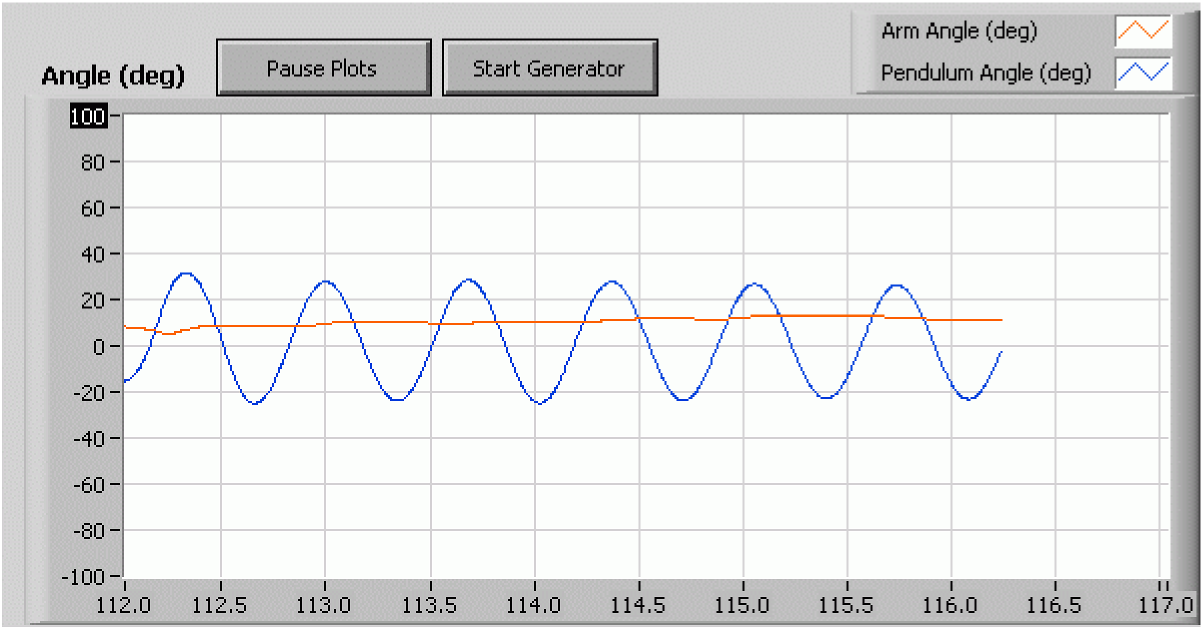

Figure 44: Changing scale of LabVIEW scope.

2. The resulting scope is depicted in Figure 45. The blue trace is now more visible.

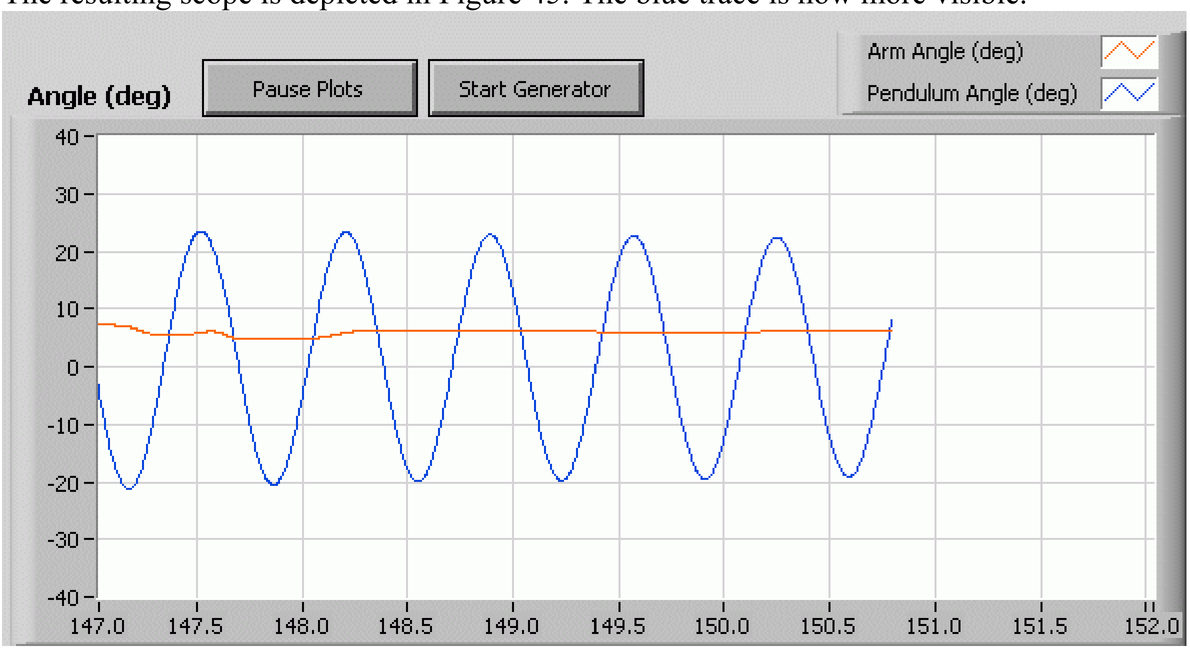

Figure 45: Y-axis of scope has been adjusted.

Similarly, the minimum range of the *y*-axis can be changed as well as the range of the *x*-axis. For example, to see a time range of 10 seconds instead of 5 seconds the *x*-axis range can be changed from [0.0, 5.0] to [0.0, 10.0]. However, when changing the *x* -axis, i.e. the time-scale, it is recommended to do the following:

1. Pause the scopes or stop the VI and clear the chart (right-click on scope, select *Data Operation* | *Clear Chart*).

2. Apply the same scale change to both the output and input scopes. Otherwise, the data plotted in each scope will not be synchronized with each other.

9.2. Saving Response

Read the following to save a scope response:

1. Right-click on the scope and select *Export Simplified Image*, as shown in Figure 46.

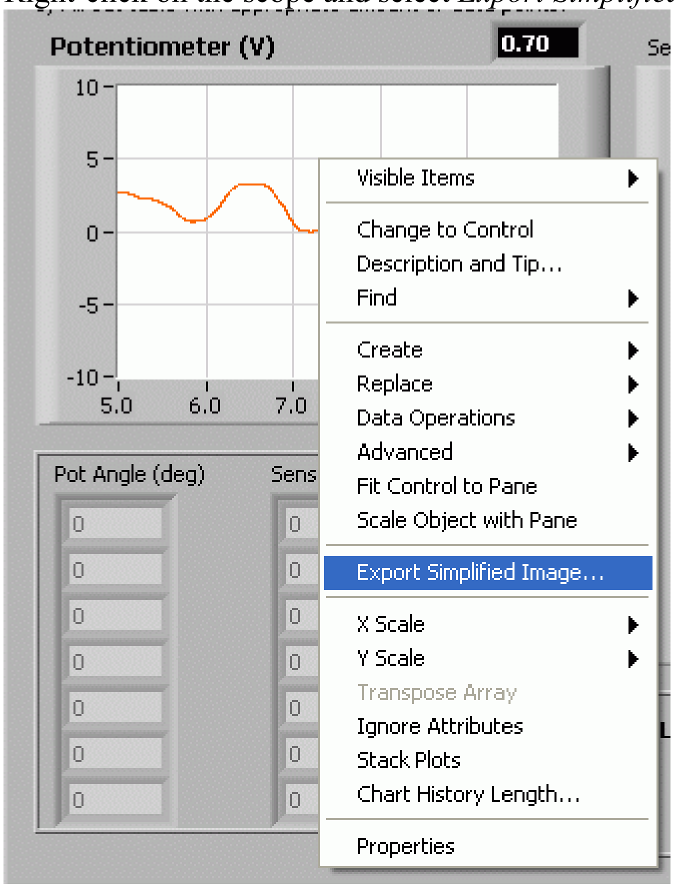

Figure 46: Right-click on scope and select Export Simplified Image.

2. The dialog box shown in Figure 47 opens and gives various image export options. One way is to export the image to the clipboard as a bitmap. This can then be pasted in a graphical software (e.g MS Paint, Irfanview) and saved to a desired format (e.g. gif).

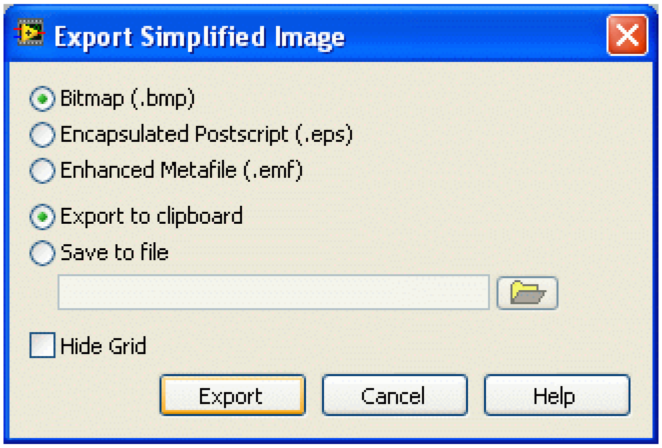

Figure 47: Export Simplified Image dialog box.

3. The resulting image that is saved is shown in Figure 48.

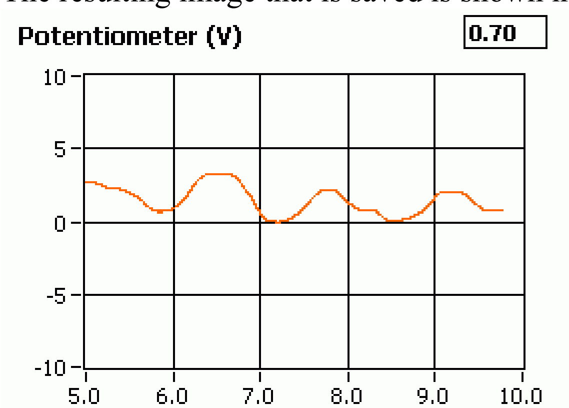

Figure 48: Sample saved response.

The scope can be saved whether or not the VI is running. However, typically it is easier to stop the VI when the desired response is collected and then export the image as instructed above.

10. Troubleshooting

10.1. General Software Issues

Q1) When I try to open a QNET VI, it says there are some missing VIs and they have a "CD" or "Sim" in the name?

The *LabVIEW Control Design and Simulation Toolkit* is not installed.

Q2) When I open a QNET VI a message prompts that a VI with "PID" in the name cannot be found?

The *LabVIEW PID Control Toolkit* is not installed.

Q3) When I open a QNET VI a message prompts that a VI with "ELVIS" in the name cannot be found?

- ELVIS I: The QNET VIs use drivers that are installed from the ELVIS 3.0 or later CD. Make sure it is installed. If the folder "\National Instruments\NI ELVIS 3.0" does not exist then it is not installed (available for download at www.ni.com as well).
- ELVIS II: The QNET VIs use the ELVISmx drivers. Make sure you install the contents of the ELVIS II CD before attempting to open any of the QNET VIs (available for download at www.ni.com as well).

10.2. General Hardware Issues

Q1) None of the LEDs on the QNET board are lit?

Make sure both the *System Power* switch, which is located on the back of the ELVIS I and II units, and the *Prototyping Board Power* switch, which is situated on the front panel of the ELVIS I and on the top-right corner of the ELVIS II, are ON. See Section 2 for more information.

Q2) On the QNET board, the +15V, -15V, and +5V LEDs are bright green but the +B LED is not lit?

Ensure the QNET power connector on the QNET board is connected with the supplied QNET power cable. See the Section 2 for more information.

Q3) At least one of the +B, +15V, -15V, and +5V LEDs on the QNET board is not lit?

- See Q2 if only the +B is not lit.
- If one or more of the +15V, -15V, and +5V LEDs is not lit then a +/-15V or +5V fuse(s) on the *Protection Board* of the NI-ELVIS I is burnt. Similarly, if the +B LED is still not lit after connecting the QNET power then the *Variable Power Supplies Fuses* on the ELVIS Protection Board are burnt. See the *Protection Board Fuses* in the *NI ELVIS User Manual* and replace the fuses as directed.

Q4) The *Ready* LED on the ELVIS II does not go on?

1. Go through the ELVIS II setup procedure outlined in Section 2.1.
2. Once completed, launch the *Measurement & Automation Explorer* software.
3. As illustrated in Figure 49, expand the *Devices and Interfaces* and *NI-DAQmx Devices* items and select the *NI ELVIS II* device.
4. As shown in Figure 49, click on the *Reset Device* button.
5. Once successfully reset, click on the *Self-Test* button.
6. If the test passed, reset the ELVIS II by performing steps 6 and 7 in Section 2.1 (i.e. shut off the *Prototyping Board* switch and *System Power* switch and turn them back on again). The *Ready* LED on the ELVIS II should now be lit.

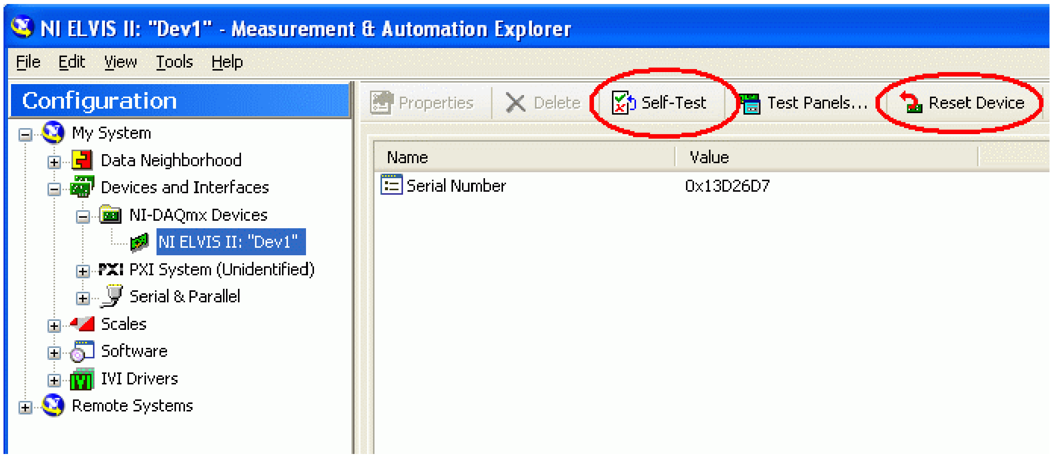

Figure 49: Reseting and performing the self-test on the ELVIS II.

10.3. HVACT Issues

Q1) When I open a QNET-HVACT VI, the scopes are all reading '0' or near '0', as shown in Figure 50, below.

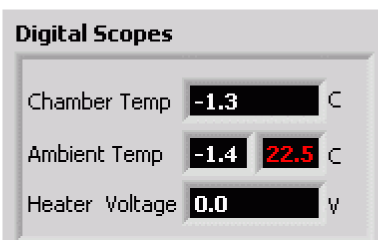

Figure 50: Scopes on QNET-HVACT VIs.

The *Prototyping Board Board* switch is not ON. The LED next to the switch should be bright green. Please review Section 2.

Q2) The halogen light does not turn on when I run the VI?

- Ensure the *QNET Power* cable is connected. The four LEDs +B, +15V, -15V, and +5V on the QNET board should all be bright green.
- Also, make sure the *Start Control* button on the QNET-HVACT VI has been clicked. The controller is enabled when this button is pressed down and the *Stop Control* caption on the button is showing.

Q3) The ambient and chamber temperatures are not accurate.

The thermistor sensors on the QNET-HVACT each have a gain and offset adjustment. They are calibrated before being shipped to match the actual temperature. However, they are relative measurements. Thus when the module is brought to different rooms with varying temperatures, the thermistor reading may not represent the actual temperature very accurately.

If the difference between the ambient and chamber temperatures is more than 10 degrees OR one of the sensors is reading an extremely inaccurate value, i.e. like a negative number, then see Section 3.6 on how to re-calibrate the thermistor sensors.

10.4. DCMCT Issues

Q1) When I open a QNET-DCMCT VI, the scopes are all reading '0' or near '0', as shown in Figure 51 below. Why are the scopes not responding when I manually move the disk load?

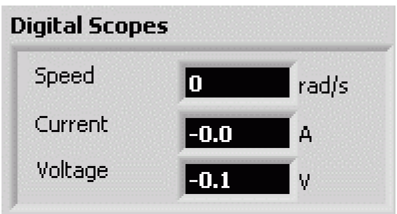

Figure 51: Scopes on speed-measuring QNET-DCMCT VIs.

The *Prototyping Board Board* switch is not ON. The LED next to the switch should be bright green. Please review Section 2.

Q2) The motor does not move when I run the VI?

- Ensure the *QNET Power* cable is connected. The four LEDs +B, +15V, -15V, and +5V on the QNET board should all be bright green.
- Make sure the *Start Control* (or *Start Generator*) button on the QNET-DCMCT VI has been clicked. The controller is enabled when the *Start Control* button is pressed down and the *Stop Control* caption on the button is showing

10.5. ROTPENT Issues

Q1) When I open a QNET-ROTPENT VI, the scopes are all reading '0' or near '0', as shown in Figure 52, below. Why are the scopes not responding if I manually move the pendulum?

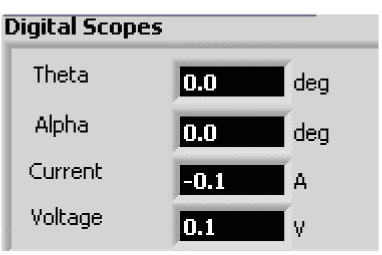

Figure 52: Scopes on QNET-ROTPENT VIs.

The *Prototyping Board Board* switch is not ON. The LED next to the switch should be bright green. Please review Section 2.

Q2) When I run the "QNET_ROTPENT_Simple_Modeling" VI the pendulum does not move?

- Ensure the *QNET Power* cable is connected. The four LEDs +B, +15V, -15V, and +5V on the QNET board should all be bright green.
- Make sure the *Start Generator* button on the QNET-HVACT VI has been clicked. The controller is enabled when this button is pressed down and the *Stop Generator* caption on the button is showing.

Q3) When I try to run the balance controller using the "08-QNET_ROTPENT_Swing_Up_Control" VI the pendulum does not move?

- Ensure the *QNET Power* cable is connected. The four LEDs +B, +15V, -15V, and +5V on the QNET board should all be bright green.
- Make sure the *Start Control* button on the VI has been clicked. The controller is enabled when this button is pressed down and the *Stop Control* caption on the button is showing. Also, note that the balance controller is only active when the pendulum is withing the upright vertical position.

Q4) When I try to run the swing-up controller using the "QNET_ROTPENT_Swing_Up_Control" VI the pendulum does not move?

- Ensure the *QNET Power* cable is connected. The four LEDs +B, +15V, -15V, and +5V on the QNET board should all be bright green.
- For the swing-up control, make sure both the *Start Control* button and the *Activate Swing-Up* toggle switch on the VI have been clicked. The controller is enabled when the *Start Control* button is pressed down and the *Stop Control* caption on the button is showing.
- Make sure the pendulum is perturbed to get the swing-up going by clicking on the *Disturbance* button in the VI.

11. References

[1] QNET-HVACT Laboratory – Instructor or Student Manual

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